

Reading Hebrew

The Language and the Psychology of Reading It



Joseph Shimron

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Psychology of Reading It*

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Psychology of Reading It*

Joseph Shimron
University of Haifa



2006

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To Yonat, Tamar, and Omri

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Preface

I often discourage students from choosing the psychology of reading as their field of specialization. This may sound odd, because this is what I research and teach, but I have my reasons: I tell them that to specialize in the psychology of reading it's not enough to understand cognitive psychology, and how it explains reading processes. You also need to know the language and the writing system that form the context in which the psychological processing of reading operates. True, you may never be a specialist in all these fields (I am not), but you should know enough about them to understand the reading processes and the possibility of viable literacy in this language.

In this book, in addition to reviewing psychological research on reading Hebrew, I introduce the reader to the Hebrew language: its structure, its history, its writing system, and the issues involved in being fluently literate in it. I have arranged the book cyclically. In the first cycle of chapters (1–4), after a short introduction to the Hebrew language, and a much longer introduction to the Hebrew word structure, I focus on aspects of Hebrew that have been specifically researched by experimental cognitive psychologists. The reader whose only interest is in the psychological mechanisms of reading Hebrew may be satisfied with the chapters in this cycle. In the second cycle (chapters 5–8), I survey briefly the history of the Hebrew language and its writing system, the origin of literacy in Hebrew as one of the first alphabetic systems, and questions raised about the viability (or possibility) of having full-scale literacy in Hebrew. Together, it is hoped, the two parts present the necessary background for studying the psychology of reading Hebrew and literacy in Hebrew.

The study of reading Hebrew by cognitive psychologists is still in its infancy. I know of very few studies conducted prior to the early 1980s. At that

time, a number of Israeli cognitivists set out to identify significant issues in the psychology of reading Hebrew, and subsequently addressed them experimentally. As we approach 25 years of research on reading Hebrew, the time seems ripe for specifying the major accomplishments of these efforts and putting them in perspective. Most research so far has addressed two issues, which are related to the basic processes of reading, at the level of word recognition. The first is the phonological processing involved in reading Hebrew—where the role of vowel signs as providing phonological information is the central issue. Phonological processing in reading Hebrew is particularly interesting due to the unique feature of Modern Hebrew (and Arabic): the existence of two orthographic systems, one that omits most vowel signs and one that specifies all phonological distinctions by means of diacritic marks (Hebrew *nekudot* ‘points’).

Secondly, I discuss the processes of recognizing Hebrew words and performing linguistic operations such as inflections. It appears that complex words (not necessarily Hebrew words) may be recognized through the recognition of sublexical elements (word particles), which occurs in addition or on the way to recognition of the word as a whole. The idea here is that experimental methods can assess readers’ sensitivity to sublexical elements. Then, if it is found that readers are sensitive to them, it may be assumed, and the assumption tested, that recognition of these elements facilitates recognition of the word as a whole. It also follows that our mental lexicon—our memory for linguistic elements—contains these sublexical elements in addition to whole words. Then it may be further assumed that the process of recognizing (reading) words may be accomplished through decomposing complex Hebrew words as part of the process of word recognition. This possibility is known as the **word decomposition** hypothesis.

In Hebrew, a word decomposition may imply extracting the consonantal root (see later) from the rest of the word, and identifying the word pattern (see later), into which the root’s consonants (sometimes referred to as root radicals) are inserted. Recognition of sublexical elements may also imply decomposition, or segmentation, of the linearly joined morphemes, which appear as affixes.

In my opinion there is a special value to investigating issues of reading (as a general process) while concentrating on those aspects in which reading Hebrew is perhaps different from reading other, non-Semitic languages. I believe that the investigation of language-specific features may possibly lead to a better understanding of reading in general.

The thrust of past and contemporary experimental work on reading worldwide has primarily been concerned with English literacy. This may well be because English has become the lingua franca of Western civilization, or perhaps because most of the funds available for psychological research on reading may well be found in English-speaking countries. Additionally, the

widespread study of English literacy may partially flow from the challenge of the intricate and complex relationship between English spelling and speech, a situation not necessarily present in the reading of other languages or writing systems. In recent years a growing number of studies on reading have been published in different languages, and I venture to contend that this research has in fact facilitated a broader perspective and greater understanding of general reading processes.

Finally, I examine the limits (or their absence) of literacy in Hebrew. This is not a practical issue for those who have grown up speaking Hebrew. For the native speaker of Hebrew, becoming literate in it is as natural as becoming literate is for every other person in his or her native language. Nevertheless, a question has been raised by historians, philosophers, sociologists, and educators who have dealt with the development of literacy in the literate world as to the ability of the ancient Hebrew writing system, which has not changed much over the centuries, to allow full-scale literacy. The authors of some of these studies have reached what I regard as mistaken conclusions about the development of the world writing systems, namely the limits and provisions that different writing systems make for extensive literacy. In the book I refer to these assertions inasmuch as they are related to the viability of reading Hebrew. I attempt to show how the psychological processes of reading Hebrew are related to the characteristics of the Hebrew language and its writing system, and consequently, how literacy in Hebrew is a viable possibility.

The first chapter is a short introduction to the Hebrew language, and is followed by a chapter that presents the Hebrew word structure more extensively. The next two chapters review experimental work on phonological and morphological aspects of reading Hebrew. The second part of the book deals more extensively with selected subjects that can provide a deeper and wider background to the Hebrew language, its writing system, and the possibility of intensive literacy in Hebrew.

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1

Introduction

The term **Modern Hebrew** in the context of this book refers to the Hebrew language that is spoken today in Israel. This language, as well as its writing system, has a long history (see chapters 5, 6, and 8). In addition, as a Semitic language, it has a unique word structure. In this introduction I briefly discuss basic facts about Modern Hebrew, before moving on in the next chapters to discuss psycholinguistic research on reading Hebrew. For a broader introduction to selected issues, I refer the reader to the second part of this book.

This introduction is short and by no means balanced or comprehensive. It does not include a section on Hebrew syntax because, except for language acquisition studies (which have little to do with reading), there seem to be very few experimental psycholinguistic studies on unique features of Hebrew syntax in relation to the reading processes. It is also my impression that the syntactic features of Modern Hebrew may be found in other languages, including those outside the family of Semitic languages. I also have little to say on Hebrew phonology, other than points directly related to reading and writing. Morphological aspects are discussed in the next chapter. For a concise but more balanced and comprehensive introduction to Hebrew, I suggest consulting Berman (1997b, 2003a), Hetzron (1987), Ornan (1971b), and Schwarzwald (2001).

Linguistic Identity

Hebrew is a Semitic language; it belongs to the Hamito–Semitic family of languages, of which few have survived. Among those that have, Arabic in its many dialects should be mentioned as the one used by more than 200 million people. In addition, several Ethiopian languages, most notably Amharic, are

also in wide use, and in a few areas Aramaic (or rather neo-Aramaic) and Syriac are also used. The number of people who speak Hebrew in Israel is over 5 million, and for many of them it is their first tongue. Modern Hebrew is studied in Jewish communities as well as in colleges and universities around the world.

The Evolution of Hebrew

Hebrew has existed for more than 3 millennia. It apparently evolved out of a northwestern branch of proto-Semitic—the ancient Semitic language in Canaan. In spite of interactions with other languages, Hebrew has maintained a remarkable stability from the pre-Biblical era to the present day (see chapter 5). Still, distinct developments occurred in Hebrew in the course of the Biblical era (1300 to 200 BCE), and remarkable advances in syntax and vocabulary took place in post-Biblical times: the Mishnaic era (500 BCE to 200 CE), the Rabbinic eras, and later, in the Middle Ages (see Ben-David, 1967, 1971).

The continuity of Hebrew use through history is no less miraculous than its revival in modern times. In fact, the revival of Hebrew during the last three centuries or so would have been impossible but for the fact that Jews around the world never ceased using it in study, in religious practice, and in communication. Important literature was written in Hebrew when the language was not actually spoken.

Modern Hebrew evolved in two stages. In the first stage, beginning in the late 18th century, under the influence of the Enlightenment, Hebrew was increasingly used in written communication among Jewish intellectuals—a process reflected in the emergence of a large number of Hebrew periodicals and books. Then, from the end of the 19th century, Hebrew was gradually reinstated as a spoken language at home, in schools, and in universities. The momentum of reviving Hebrew in the modern era was certainly related to nationalist motivation. This was true at the early stage of the Hebrew revival in Europe, and even more with the rise of Zionism. Berman (1997b) put it thus:

Hebrew constituted a focal point of communality between the different sectors of the Jewish population in Palestine: devout Jews scattered around the Holy Land, pioneers of Zionist immigration (mainly from eastern Europe) from the late 19th century, and large influxes of Jewish refugees from Europe and the middle East before and after World War II, and in the early Israeli statehood. (p. 312)

The 5 million people in Israel who speak Hebrew as their dominant language use it in each and every field of life: education, business, law, science, administration, and the media.

Main Features of Hebrew as a Semitic Language

The most prominent feature of Hebrew words, common to other Semitic languages, is that the words' **base**, to be defined shortly, is composed of two bound morphemes (word elements that cannot occur as separate words). These morphemes are the **root** and the **pattern**.

The base itself is the central element of complex words—the element left when all affixes are stripped. In the analysis of non-Semitic languages, it is often referred to as the word's "root," which is sometimes a word in its own right; therefore not a bound morpheme and it cannot be further divided. This is of course a different kind of root from the one referred to in discussing Semitic words.

The Semitic root is generally composed of three consonants (but see Rose, 2003). However, although the root is not a word, it is associated with a core meaning, which may be inferred from the group of words in which it is embedded. Consider the following list of words (for clarity, root consonants are capitalized):

KaTaV 'he wrote'

KaTaV-nu 'we wrote'

KaTaV-a 'media item'

mi-XTaV 'letter or message' (/k/ and /x/ interchange in certain linguistic contexts)

KTóV-et 'address'

KTuV-im 'scriptures'

KaTuV 'is written'

be-hit-KaTV-ut 'by correspondence'

All these words share the consonants K, T, and V, the three radicals of the root K-T-V, and all the words in this list have something to do with writing. When Hebrew speakers become aware of the core meaning of a root they can create new words, in which this root is embedded. For example, the word *KuTaV-ti* 'something was written about me', does not presently exist, but it is a possible (or potential) word because both the root and the pattern (see below) do exist. Therefore, aside from its phonological role, the root functions as a semantic determinative that indicates a certain semantic field, deduced from the words in which the root is embedded.

As can be seen in the examples above, the root consonants are inserted into the pattern in a noncontinuous, nonlinear manner; namely, in among the vowels (and other consonants) of the word pattern. Also, because the word's base in Semitic languages can be further divided into a root and a pat-

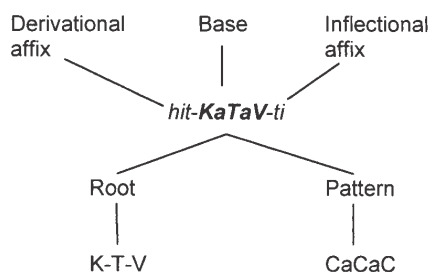


FIG. 1.1.

tern, the structure of Semitic words may be seen as having at least two tiers: the surface tier, which contains the base and its affixes, and a deeper tier, which consists of the base's elements (bound morphemes), that is, the root and the pattern (cf. Frost, Forster, & Deutsch, 1997; Deutsch, Frost, & Forster, 1998; also see the extended discussion in chapters 2 and 4 of this book). Figure 1.1 portrays this hierarchy schematically. The word analyzed in the figure is *hitkatavti* 'I was corresponding' (1st, sing. past). The word's root is K-T-V (core meaning = write), the verbal pattern is in *binyan hitpa'el*. Hyphens and bold fonts were inserted for clarification. The pattern's capital Cs stand for the slots into which the root's consonants are inserted.

Note that the pattern in Fig. 1.1 is the vocalic pattern of the base. Another view of the pattern is presented in chapter 2, and defines the pattern as whatever is left of the whole word when the root is extracted. That is, the base pattern plus affixes if they exist. The pattern always contains vowels with which the root consonants are articulated, but in many cases it is also flanked by other vowels and consonants, which may be considered affixes. The patterns in which the root K-T-V is inserted in the example shown above are associated with a variety of speech parts: verb inflections, as in the first two examples, noun (nominal) patterns, as in the next four examples, an adjective in the following example, and an adverb in the last. The pattern thus indicates the syntactic characteristic of the word.

Other common features of Hebrew as member of the Semitic family of languages are less easy to pinpoint. One important feature is the etymological similarity of words in different Semitic languages. For example, the Hebrew and the Arabic words *bayit/beit*, both mean 'house'. Examples like these can be found in abundance; they certainly indicate linguistic proximity, if not a common origin. This question is discussed in more detail in chapter 5.

Speech and Writing

Chapter 6 provides an extensive review of the Hebrew writing system and its development, and in chapter 3 the psychological aspects of phonological proc-

essing in reading Hebrew are reviewed. Here I present the most basic concepts about the Hebrew writing system and its phonological features and notation.

As in the earliest Semitic alphabets, the Hebrew writing system is basically consonantal. It contains 22 letters that stand for consonants. Vowels were originally not indicated at all, and in some early Semitic alphabets (e.g., Phoenician) they were never indicated. But from a very early stage of its development the Hebrew writing system assigned four consonant letters (*alef*, *he*, *vav*, and *yod*) a second role, namely, to indicate some of the vowels. Yet such a presentation of vowels in print was never adequate. *Alef* represented several Hebrew vowels, *he* represented a vowel only when standing at the word's end, *vav* represented the vowels /u/ and /o/, and *yod* represented the vowel /i/ in most of the cases, but also the vowel /e/ in a few others (see chapter 3).

In the 8th and 9th centuries CE, a system of representing vowels by diacritic marks (dots and strokes, usually below, but sometimes above or in the middle of the consonant letters) was adopted. This system provides a complete representation of Hebrew vowels. However, very few texts in the daily reading of Hebrew readers today are printed with these signs, and one of the challenges of psycholinguists today is to explain why reading a fully vowelized text is not remarkably easier or faster than reading a vowel-less text.

The representation of Hebrew consonants in letters is generally straightforward, although there are some difficulties. First, the Hebrew language apparently always had more consonants than those sounded by the 22 consonant letters featured in the Semitic alphabet in Canaan. Therefore, some letters had to represent more than one phoneme (a basic unit of speech sound). As we see later in chapter 3, when a dot is placed in the middle of the letters *bet*, *kaf*, and *pe*, in a text written with the diacritic vowel signs (*nekudot* 'points'), the letters indicate consonants /b/, /k/, and /p/, respectively; when the dot is absent they indicate /v/, /x/, and /f/, respectively. Historically, another group of letters, *gimel*, *dalet*, and *tav*, stood for two phonemes when written with or without a dot, but the distinction was not preserved. Another letter which represents two consonants is *shin*. It represents /ʃ/ (sh) when a dot is placed above its upper right-hand corner and /s/ when the dot is placed above its upper left-hand corner. Needless to say, without the diacritical marks, in the unpointed text the letters *bet*, *kaf*, *pe*, and *shin* may be ambiguous. However, with familiar words the ambiguity is almost always resolved by so-called top-down processing, a process which begins at the "top" with the recognition of the whole word, and then goes "down" to verify the basic elements.

In addition, the writing of a number of consonants is ambiguous because some Modern Hebrew sounds may be represented in writing by more than one letter (see Table 1.1). In unpointed text the phoneme /k/ may be written by either *kaf* or *kof*, the consonant /v/ by either *vav* or *bet* (*vet*), /x/ by either

TABLE 1.1
Modern Hebrew Alphabet and Pronunciation

Name	Letter	Pronunciation
alef	א	Ø or '
bet	ב	b-v
gimel	ג	g
dalet	ד	d
heh	ה	Ø, ', h
vav	ו	v
zayin	ז	z
chet	ח	x
tet	ט	t
yod	י	y
kaf, chaf	כ	k-x
lamed	ל	l
mem	מ	m
nun	נ	n
samech	ס	s
ayin	ע	Ø, '
pe, fe	פ	p-f
tsade	צ	c
kof	ק	k
resh	ר	r
shin, sin	ש	š, s
tav	ת	t

Note. The following pronunciation marks sound as follows:

1. The sign Ø stands for a complete closure of the glottis, in fact, no consonant.
2. The sign ' stands for the glottal consonant, like the English /ah/.
3. The sign x stands for the last consonant in the name Bach.
4. The sign c stands for the /ts/ or /tz/ cluster.
5. The sign š stands for the English consonant /sh/.

kaf (xaf) or *xet*, and /s/ by either *shin* (*sin*) or *samex*. Regardless of the diacritical marks, the consonant /t/ may be written by either *tav* or *tet*, and the glottal stop /' / by *alef*, *'ayin*, or *he*. (A glottal consonant is one that is produced in the larynx by closing or narrowing the aperture between the vocal folds.)

This last potential confusion may result from a linguistic phenomenon known as leveling or neutralization. It means that the contrast between distinct phonemes is gradually reduced to the point where the phonemes that once were different are no longer distinguishable.

Diversity of pronunciation is also a factor affecting writing complexity. Originally *xet* and *'ayin* were pharyngeals (consonants produced by constriction of the pharynx); in Modern Hebrew, they are better preserved by people who immigrated to Israel from Arabic-speaking countries than by speakers from other countries. In the speech of second- and third-generation native

TABLE 1.2
Modern Hebrew Vowels

Vowel Name	Vowel Sign	Pronunciation
Shuruk	וּ	u
Kubuts	וּ	u
Holam Male	וּ	o
Holam Haser	וּ	o
Kamats Katan	וּ	o
Kamats (Gadol)	וּ	a
Patach	וּ	a
Hataf Kamats	וּ	a
Hataf Patah	וּ	a
Segol	וּ	e
Tsere	וּ	e
Hataf Segol	וּ	e
Hirik Male	וּ	i
Hirik Haser	וּ	i
Schwa Na	וּ	Ø
Schwa Nach	וּ	Ø

Note. The sign וּ stands for every Hebrew letter.

Israelis, or of those who emigrated from Western countries, *xet* is reduced to the velar /x/ (a sound produced by the back of the tongue in approaching the palate), which is indistinguishable from the unpointed *kaf* (*xaf*), the *'ayin* is reduced to the glottal stop (see above), similar to the *alef*. In the speech of many Israelis, regardless of origin, the *he* is also pronounced as a glottal stop, similar to the *alef*.

The Modern Hebrew vowel system contains the five basic vowels: /i/, /u/, /e/, /o/, and /a/ (see Table 1.2), and three diphthongs (vowel clusters) /ay/, /oy/, and /uy/. There is no phonetic contrast of short versus long vowels in Modern Hebrew, but the writing of vowels is a persistent problem. We noted that the vowel /i/ is written by the vowel letter *yod*, and in most of the cases such a rendering would be unambiguous. Similarly, both vowels /o/ and /u/ are written by the vowel letter *vav*. The main difficulty here is that these three vowel letters sometimes appear as consonants and sometimes as vowels, and without familiarity with the whole word one cannot tell which is which. Another difficulty is that not /i/ nor /o/ nor /u/ is always written by a vowel letter. Sometimes, in unpointed text, such vowels are not indicated at all.

Vowel writing with diacritical marks is even more problematic. Generally, the vowel signs are unambiguously recognized for what they are (the one exception is the use of the *kamatz*, which usually stands for /a/, but occasionally for /o/). But owing to historical distinctions that are no longer in practice,

every one of the basic five vowels can be marked with more than one sign. This difficulty will probably not be resolved without a general reform of current Hebrew spelling. The fact is that Modern Hebrew speakers for the most part have no difficulty reading the pointed text, but are practically unable to employ the diacritical marks in spelling. More specifically, even well-educated Hebrew writers spell the Hebrew vowels in different ways.

Table 1.1 (adapted with some omissions from Berman, 2003a) shows the Hebrew alphabet and its pronunciation as they appear in the linguistic literature. The phonetic markers reflect the phonology of Modern Hebrew as pronounced by most native Hebrew speakers. Note the similarity in the pronunciation of *alef*, *he*, and *ayin*; *vet* and *vav*; *xet* and *xaf*; *tet* and *tav*; *kaf* and *kof*; and *sin* and *samex*.

2

The Hebrew Word

Most experimental research in the psychology of reading Hebrew concentrates on deciphering Hebrew words. To provide the background knowledge needed for an understanding of this research, I describe the structure of Hebrew words in this chapter. The first part of the chapter is a brief introduction to the structure of Hebrew words; the second is a more extensive discussion of constructs such as root, pattern, and word structures in the verbal and nominal word groups (*binyanim* and *mishkalim*; see below). The intention is not to furnish a linguistically balanced or exhaustive description of Hebrew words (for this purpose I suggest a reading list at the end of the chapter); rather, the chapter is catered to those who study the psychology of reading Hebrew.

INTRODUCTION

Hebrew words, like words in other Semitic languages, are characterized by a rich, bound morphology (see chapter 1), both inflectional and derivational. All content words (i.e., nouns, verbs, and adjectives) and some closed class items (i.e., pronouns and prepositions) in Hebrew are marked by a rich array of inflectional affixes. In addition, all verbs and most nouns and adjectives are based on consonantal roots, which are inserted (nonlinearly) into existing canonical (regular) patterns, also referred to as **templates** or **schemes**.

Word Structures

Nouns and adjectives that syntactically agree with them are distinguished for number (singular/plural) and gender (masculine/feminine), and they may

also be marked for definiteness by the prefixal *ha-* ‘the’, as can be seen in (1) (hyphens are added for clarity):

1. a. *kadur* (mas. sing.) *gadol* ‘ball big’ = ‘a large ball’
- b. *kubi-a* (fem. sing.) *gdol-a* ‘block big’ = ‘a large block’
- c. *kadur-im* (mas. pl.) *gdol-im* ‘balls big’ = ‘large balls’
- d. *kubiy-ot* (fem. pl.) *gdol-ot* ‘blocks big’ = ‘large blocks’
- e. *ha-kadur ha-gadol* ‘the ball big’ = ‘the big ball’
- f. *ha-kubiy-ot ha-gdol-ot* ‘the blocks big’ = ‘the big blocks’

We see that the singular masculine noun and the adjective that agrees with it are unmarked. The singular feminine noun and its respective adjective are marked by the suffix *-a* (there are a few other feminine word endings, and some feminine nouns are unmarked). The masculine plural noun and its adjective are marked with *-im*, and the feminine are marked by *-ot*.

Examples of noun patterns, *mishkalim* (adapted from Berman [2000]) are presented in (2):

2. Noun patterns based on the roots G-D-L (core meaning, ‘grow’, ‘big’), and K-T-V (core meaning ‘write’) in a selection of nominal patterns (*mishkalim*). Note that the stop *k* consonant is occasionally replaced by the fricative *x* (see Table 1.1) (the ‘ sign marks accent where it is not at the last syllable).

Noun Patterns (*mishkalim*)

	G-D-L ‘grow’	K-T-V ‘write’
CóCeC	<i>gódel</i> ‘size’	—
CCaC	—	<i>ktav</i> ‘writing type’
CCiC	—	<i>ktiv</i> ‘spelling’
CaCaC	—	<i>katav</i> ‘correspondent, reporter’
CaCaCa	—	<i>katava</i> ‘media-story’
CCuCa	<i>gdula</i> ‘greatness’	<i>ktuba</i> ‘marriage-contract’
CaCCan	—	<i>katvan</i> ‘typist’
CaCCanut	—	<i>katvanut</i> ‘typing, stenography’
CaCCut	<i>gadlut</i> ‘grandeur’	—
CCóCet	—	<i>któvet</i> ‘address’
miCCaC	<i>migdal</i> ‘tower’	<i>mixtav</i> ‘letter (to be delivered)’
taCCiC	<i>tagdil</i> ‘enlargement’	<i>taxtiv</i> ‘a dictate’
maCCeCa	—	<i>maxteva</i> ‘writing-desk’
tiCCóCet	—	<i>tixtóvet</i> ‘correspondence’

We can see that the pattern system is not fully productive, many gaps (later to be defined as “empty cells”) exist for any one pairing of a given con-

sonantal root and a canonical pattern. Also, the form-to-meaning relationship varies within the same pattern. For example, the pattern miCCaC has both *migdal* 'tower' and *mixtav* 'letter', which are objects or products, but other roots inserted into the same pattern may stand for a location, for example, *mitbax* 'kitchen' and *misrad* 'office'.

Verbs too are marked for number (singular and plural), gender (feminine and masculine), person, as well as for tense (present, past, and future) and imperative mood. Compare:

3. a. *ha-kadur nofel* 'the ball (is) falling' (mas. sing. present)
- b. *ha-kadur-im nofl-im* 'the balls (are) falling' (mas. pl. present)
- c. *ha-kubiy-a nofel-et* 'the block (is) falling' (fem. sing. present)
- d. *ha-kubiy-ot nofl-ot* 'the blocks (are) falling' (fem. pl. present)
- e. *ha-kadur nafal* 'the ball fell (down)' (mas. sing. past)
- f. *ha-kubiy-a nafal-a* 'the block fell (down)' (fem. sing. past)

In addition, all non-nominative pronouns (i.e., in syntactic positions other than as sentence subject) take the form of bound suffixes attached to a prepositional stem. For example:

4. a. *le* 'to' + *ani* 'I' = *li* 'to me' (1st mas./fem. sing.)
- b. *le* 'to' + *hi* 'she' = *la* 'to her' (3rd fem. sing.)
- c. *le* 'to' + *anaxnu* 'we' = *lanu* 'to us' (1st mas./fem. pl.)

For example, the sentence 'The gift (was) given to me' would be translated into Hebrew as: ' *ha-matana nitna li* .

The Two Kinds of Derivations

A. One kind of derivation is achieved by combining patterns and consonantal roots. The root consonants merge into the patterns by being inserted (intercalated or interdigitated) into open slots reserved for them among vowels in every pattern. For example, the root consonants G-D-L 'grew' slip into the pattern CaCaCti, forming *gadalti* 'I grew' (capital Cs stand for the root consonants, lowercase letters represent vowels and affixes).

B. Another kind of derivation is achieved by linear affixation to the word base or stem (see following definitions), such as the combination of the base *pardes* 'grove' with the suffix *-an*; together they form *pardes-an* 'one who owns a grove or cultivates it'. The linear affixation elements are marked off by hyphens in (5).

Shown in (5) below are patterns of verbs, nominal agents, and action nouns (grouped in *binyanim*; singular *binyan*), and patterns of nouns (called *mishkalim*; singular *mishkal*). All types consist of a discontinuous vocalic pattern, at times prefixed and/or suffixed by consonants and vowels.

5. Verbs, action nominals, and agent nouns based on the consonantal roots G-D-L (core meaning ‘grow’, ‘big’), and K-T-V (core meaning ‘write’) in a selection of patterns (adapted from Berman [2000]). Note that the stop *k* consonant is occasionally replaced by the fricative *x* (see Table 1.1).

G-D-L ‘grow’		K-T-V ‘write’	
Verbal Patterns			
<i>binyanim</i>			
CaCaC	<i>gadal</i> ‘grow’ [intransitive]	<i>katav</i> ‘write’	
niCCaC	—	<i>ni-xtav</i> ‘be written’ [passive]	
CiCeC	<i>gidel</i> ‘grow, raise’ [transitive]	<i>kitev</i> ‘write captions’	
hitCaCeC	<i>hit-gadel</i> ‘self-aggrandize’ [reflexive]	<i>hit-katev</i> ‘correspond’ [reciprocal]	
hiCCiC	<i>hi-gdil</i> ‘enlarge, magnify’ [causative]	<i>hi-xtiv</i> ‘dictate’ [causative]	
Action Nominal Patterns			
CaCaC	<i>gdil-a</i> ‘growing, growth’	<i>ktiv-a</i> ‘writing, script’	
CiCeC	<i>gidul</i> ‘growth, tumor’	<i>ktiv-it</i> ‘caption’	
hitCaCeC	<i>hit-gadl-ut</i> ‘aggrandizement’	<i>hit-katv-ut</i> ‘corresponding/ence’	
hiCCiC	<i>ha-gdal-a</i> ‘enlarging/ement’	<i>ha-xtav-a</i> ‘dictating/ion’	
Agent Nouns			
CaCaC	—	<i>kotev</i> ‘author’	
CuCaC	—	<i>me-xutav</i> ‘addressee’	
CiCeC	<i>me-gadel</i> ‘grower’, ‘farmer’	—	

We may consider the two derivational modes as complementary. For example, the root N-H-G, when embedded in the canonical pattern maCCiC, to form *manhig* ‘leader’, may be then suffixed with *-ut* to produce *manhig-ut* ‘leadership’. The root Y-L-D when embedded in the pattern CeCeC forms the noun *yeled* ‘child’, or its bound (stem) form *yald-*, which, with appended affixes, serves to form the derived nouns and adjective *yald-ut* ‘childhood’, *yald-ut-i* ‘childish’, and *yald-ut-i-yut* ‘childishness’ (hyphens are added for clarification).

Bases and Stems

In addition to roots and patterns, two basic constructs of Hebrew word structures are the **base** and the **stem** (see Schwarzwald, 1998; Ravid, 1994; Ravid & Shlesinger, 2001). As defined here, the **base** is the uninflected and undervived word form, frequently a word in its own right. The base is also the central element in Hebrew complex words. In complex words, I refer to the base as a **stem**. Stems are distinguished by their vowel patterns, which may or may

not be identical to the vowel pattern of the base. For example, the nominal base *derex* 'way', which has the root D-R-K (the phonemes /k/ and /x/ alternate in different word contexts), may be realized in different stems: *dark-i* 'my way', *drax-im* 'ways', *darx-ey* 'the ways of', and so on. Each stem is comprised of the consonantal root, combined with a distinct vocalic pattern with which it is coarticulated. As a second example, the root G-D-L (core meaning 'grow', 'big') combined with the vocalic pattern -a-a- (hyphens stand for consonants) forms the verb *gadal* 'he grew'. No affixes appear in this word. However, the base represented by the root G-D-L may be conjugated, like all verbs, by accepting affixes to mark tense, number, gender, and person, for example, *gadal-ti* 'I grew', *gadal-nu* 'we grew', *e-gdal* 'I will grow', and *ti-gdel-u* 'you will grow' (stems are marked here in bold letters, and hyphens are added for clarity).

The canonical pattern specifies the vowels, and indicates grammatical features by affixes (e.g., number, gender), but like the root, it has no definite pronunciation. Unlike the root and the pattern, the stem and the affixes have a clear phonological realization.

The formation of Semitic words may be seen as a simple mechanism consisting of two lists: one relatively short, with no more than a few hundred, consists of patterns for forming nouns, verbs, and so on, and one much longer, of several thousand roots, in fact an open list. In a certain sense, the Periodic Table in chemistry can serve as a metaphor for this word production system. Ornan (1983a, 1983b, 1990a, 1990b, 2003) suggested that the two lists could be imagined as two axes of a huge matrix, where words are placed in cells that correspond to a certain pattern on the pattern axis and to a root on the root axis. The intersection of the two axes may be regarded as a cell containing a word, or, if empty, may yield a potential word in the future. Ephratt (1985) suggested the existence of two tables, one ordered by phonological criteria and the other by semantic ones.

The fact that not every cell is actually occupied leaves room for the construction of new words without the addition of roots or patterns to the matrix as a whole. The availability of these open slots appears to facilitate the innovation of words. But if a proper slot is already occupied, other new words that would generally match the semantic expectations of this slot will have to be cast in another *binyan* or *mishkal*—in another vacant cell in the overall matrix. For example, a person who hurts others in traditional Hebrew is *poge'a* (plural *pog'im*). In recent years another word, having the same meaning and built from the same root, *mefage'a*, has appeared, formed with another pattern, which until recently was not in use with this particular root.

Ornan recognized that not every possible word has to be placed in the matrix, because some inflections are in fact so productive, and their meaning is so predictable that they may not need to occupy independent cells. When

needed, they may at times be created by a production mechanism in which the word formation process is accomplished by linear affixation and/or vowel alternation. In principle, therefore, Ornan's suggestion is not incompatible with an approach assuming two central mechanisms for Hebrew word formation: linear and nonlinear.

Note how the two kinds of derivations accomplish the same goal: The noun *rakdan* 'dancer' may be produced either by affixation, that is, *rakad* 'danced' plus the suffix *-an* $\Rightarrow$ *rakdan* 'dancer', or by inserting the root R-K-D into the nominal pattern CaCCan. The two options (word + suffix; pattern + root) are, in this case, equally plausible (cf. Bolozky & Schwarzwald, 1992; Schwarzwald, 1998, 2001). Indeed, the two procedures of word formation may be regarded as affixation: either a linear affixation to the word base or a nonlinear affixation of the consonantal root into the word pattern.

However, to some extent, these alternative views of word formation are differently applied to different word groups. For example, in the verbal group, the affixes clearly play the role of conjugations in a relatively productive manner. The situation appears more complicated in the noun group, where word beginnings and word endings such as those in *ma-zker-et* 'souvenir' can be easily recognized as recurrent patterns, even though they are not generally considered as morphemes.

Finally, focusing on word stems, rather than roots and patterns, vowel alternation in the word's stem may itself be considered a mechanism (or submechanism) of inflection in Hebrew. Compare the differences between third person singular in various tenses and the imperative in the first *binyan*, *pa'al*:

6. a. *KaTaV* 'he wrote' (3rd mas. sing. past)
- b. *KoTeV* 'he writes' (3rd mas. sing. present)
- c. *KToV* 'write!' (mas. sing. imperative)

No affixation is involved in this type of inflections; tense and mood distinctions here are achieved solely by alternation in the vocalic pattern. Yet even when affixation is involved in verbal inflection, vowel alternation in the word's stem is frequently the distinctive parameter. An instance is the differentiation of voice (active-passive) across *binyanim*, such as that between active *pi'el* and passive *pu'al* in (7):

7. a. *kibad-ti* '(I) honored' (1st mas. sing. past) (*pi'el*)
- b. *kubad-ti* '(I) was honored' (1st mas. sing. past) (*pu'al*)

True, vowel alternation in the word's stem may be seen as pattern variation within the approach of root-pattern word formation. However, psychologically (if not linguistically) it may be justified to distinguish between the

two kinds of word formation: affixation, and vowel alternation in the word's stem. Empirical evidence of the independent psychological effect of affixation and vowel alternation is set out in Ravid (1995) and Vaknin (2004). It may be suggested, however, that in word formation by vowel alternation, the word's base/stem (and the affixes), not the root and the pattern, feature as the central linguistic units.

Finally, inflection by affixation and inflection by vowel alternation, as can be seen in (6) and (7) above and in (8) below, are to some degree independent. Some inflections are achieved exclusively by affixation, with no vowel alternation in the word's stem, others by vowel alternations only (as in [6]), and still others by both mechanisms, as in (8):

8. a. *yeled*—*yelad-im* 'boy' (sing./pl.)
- b. *yald-a*—*yelad-ot* 'girl' (sing./pl.)
- c. *barak*—*brak-im* 'lightning' (sing./pl.)

Inflection by vowel alternation only is known as **apophony** or **ablaut**. It reminds us of tense inflection in a family of English words such as *sing*—*sang*—*sung*, *ring*—*rang*—*rung*, and many more (cf. Bolozky, 1996; Heath, 1987; Pinker, 1999). Ravid (1995) and Ravid and Shlesinger (2001) demonstrated that at early stages of linguistic development and among Hebrew speakers of low socioeconomic status, words having stems with alternating vowel patterns are often incorrectly used, unlike the case with word stems that do not undergo alternation. As is shown in chapter 4, the psychological aspects of stem changes on word processing in adult Hebrew speakers were investigated by Berent, Pinker, and Shimron (1999, 2002) and by Vaknin (2004). Vaknin seemed to demonstrate that both vowel alternation and irregular inflections slow down the processing of inflections.

KEY CONSTRUCTS OF HEBREW MORPHOLOGY

As noted, the aim of this chapter is to provide a background for understanding empirical research on Hebrew morphology. A more elaborated discussion of some central constructs is offered here.

The Root

The exact role of roots in Semitic languages is sometimes debated (Bat-El, 1994; Bolozky, 1999; Ornan, 1971a, 2003; Shimron, 2003), but the very existence of roots is never questioned. The root may be considered an “after-the-fact” abstract concept, reflecting relationships between related words.

Roots, like patterns, appear invariantly in different words, the same root figures in different patterns, and a single pattern merges with different roots. Thus they stand out as invariant and independent entities, and can be easily identified or employed in forming new words.

Even if it turns out that in word recognition processes the speaker or the reader does not derive words from roots and patterns, perhaps because he or she pays attention only to stems or whole words, the empirical evidence set out in chapter 4 shows that a Hebrew speaker can easily identify roots. If necessary, he or she can inflect them in various ways to produce derivations based on such roots—even if the roots are extracted from loan words.

An interesting question is whether there are any restrictions on the appearance of consonants in Semitic roots. The frequently quoted study of Greenberg (1950) notes several restrictions on the appearance of consonants in triradical Semitic roots. Greenberg dealt with the identity restriction, disallowing the co-occurrence of identical consonants in one root. There are two types of identities. One is the homogeneous identity, namely the same consonant appears twice, for example, SMM or SSM or MSM. The other is “homorganic” identity, namely identity of place of articulation (the place in our vocal tract where a consonant is produced by a brief closing or a continuous narrowing of the air stream). Examples for homorganic identity are DTN, where the first two phonemes have the same place of articulation, or NPB, where the last two phonemes have the same place of articulation. Complete identity of all root consonants such as SSS never occurs, but identity of two consonants does occur in certain environments. As we are mostly dealing with triradical roots, there can be three potential types of such identities: first–second, second–third, and first–third identical radicals. Greenberg (1950) suggested that for first–second radicals both complete identity (SSM) and homorganic (DTN) are prohibited. Second–third homorganic identity of radicals is disallowed, but complete identity is not, whereas first–third identity is partially restricted on both counts (for a more extensive discussion of root restrictions, including a review of studies of this matter that preceded Greenberg, see Ephratti, 1985).

The restrictions on identity of root consonants have recently aroused new interest as a result of the development of Autosegmental Phonology and its ramifications. The theory of Autosegmental Phonology was initially used to describe tonal phenomena, but later expanded to cover other levels of representation (Goldsmith, 1990). It assumes that morphological elements such as stress, tone, consonants, and vowels are represented as independent entities, as if standing on different tiers. Moreover, the theory does not require a one-to-one correspondence between the elements on the different tiers but conceives of a one-to-many linkage. Thus, rising tones or falling tones can span several phonemes, and similarly, vowels can stretch continuously across a

string of consonants. In the Semitic word stem the separation of morphological elements such as consonants and vowels may have particular significance in supporting the view that roots (almost always comprised of consonants only) are psychologically separate morphemes. However, in the course of word processing the separated tiers of consonants and vowels are eventually interconnected by a process of tier confluence to form the word skeleton (McCarthy, 1979). This skeleton is perceived as a sequence of timing units appearing as a skeletal tier, represented by the linear sequence of consonants and vowels.

The view of root consonants and vowels as subword entities was elaborated by McCarthy (1979, 1986), who suggested that Greenberg's restrictions on radical identity of roots can be explained by a principle that, again, was first suggested for analyzing tonality, namely the Obligatory Contour Principle (OCP). The OCP (originally proposed by Leben, 1973) prohibits identical adjacent phonological elements. If we accept that a Semitic root is linguistically a separate entity (metaphorically, represented on a separate tier), then a restriction on first-second and second-third radical identity can be applied to roots exclusively, that is, notwithstanding the location of vowels as phonological elements in among the root consonants. If so, the OCP construct may explain the identity restrictions in consonantal roots.

Why are second-third co-occurrences of root letters not restricted, like first-second co-occurrences are? McCarthy (1979) suggested an elegant theory to explain this. He assumed that roots such as SMM are the product of an underlying biliteral (two-consonant) root such as SM. However, to become aligned with the canonic triradical pattern of Semitic words, a process of left-to-right spreading (i.e., SM > SMM), namely duplication of the final radical of the biradical root, produces SMM. Presumably, only the second consonant is free to spread because the initial consonant has no empty open slot to its right. Indeed, at least in Hebrew, the number of SSM roots is extremely rare, but SMM roots are not uncommon.

According to this theory, gemination—duplication of the last root consonant—is performed online in our linguistic processing. That is, every time we process a word like *XaGaG* 'celebrated', we retrieve *XaG* 'celebrate' from the mental lexicon and duplicate the last consonant. So by McCarthy's OCP, gemination is banned from the lexicon: The lexical representation of roots such as X-G-G is the biconsonantal X-G. The geminates surface during the process of word utterance, and the final triradical root, in which the final two radicals are geminates, is the surface manifestation of a biradical root in the mental lexicon. This implies that the root X-G-G as such does not exist in the mental lexicon of Hebrew speakers.

As suggested by Bat-El (1994), and corroborated by Berent and Shimron (1997), the fact that surface nonadjacent consonants seem to be controlled by the OCP in fact constitutes an argument that they are adjacent at some

level in the grammar. This is the level where the root consonants form an independent unit. Therefore the co-occurrence restriction supports an argument for the morphologically independent existence of a consonantal root in Semitic languages.

Obviously, if one does not accept the premises of autosegmental theory one can think of other explanations for the co-occurrences restrictions of root consonants. Schwarzwald (1973–1974) accounted for Greenberg's restrictions on phonological–phonotactic grounds. Also, if one does not agree with the idea of separate tiers for consonants and vowels, so that all phonemes stand, as it were, on the same tier, then in most cases the OCP would not hold because often a vowel exists—on the surface—in between identical consonants. As for constructions where vowels do not intersperse between identical or homorganic consonants, Schwarzwald suggested that, in Hebrew, identical consonants tend to merge. As a result, the root is not necessarily the basic unit of Hebrew morphology. Rather, one should take the *binyan*'s pattern or the word's base as the basic unit of Hebrew words.

Incidentally, the OCP does not explain the restriction on first–third radical identity, nor does it explain instances in Arabic and Hebrew where in some constructions a triradical root transforms into a quadriradical root by duplicating (geminating or augmenting) a middle consonant. Be that as it may, psychologically, even if we disregard the multitier theory, we may still exploit the inherent restrictions on Semitic roots by examining speakers' sensitivity to these restrictions; if such is found, we may conclude that Semitic roots as such do have a unique role in the linguistic process.

Word Patterns

The Semitic word pattern is simply whatever is left of the word after the root is extracted. It consists of a vowel pattern, the group of vowels that are co-articulated with the consonantal root, and in most cases it is also prefixed and/or suffixed to denote grammatical features such as gender and number in nouns and also tense and person in verbs.

Regarding the Semitic pattern in general, Goldenberg (1994) emphasized that its major characteristic is its three open slots for accommodating consonantal roots. This is equally true for verbal and nominal word forms. The three-slot structure is so central that it may also be applied to the few two-, four-, and five-consonantal roots. Even these exceptional roots are inserted preserving the three open slots of the Semitic pattern. Goldenberg showed how four- and five-consonant roots are “pressed, as far as possible to fit in a three-place pattern” (pp. 37–39). Two or even three consonants are clustered into one or more of the canonical three slots. For example, the quadriconsonantal Hebrew root G-L-G-L ‘wheel’ is cast in *pi’el*, an intensive *binyan*,

to form *GiLGeL* ‘rolled’, in the same way as the triconsonantal root P-K-D ‘command’ forms *PiKeD* ‘commanded’. A quinqueradical root behaves in a similar manner: *TiLGReF* (from a loan word meaning ‘telegraph’), which has a five-radical root, is compressed into the same pattern that accommodates *GiLGeL* (quadriliteral root) and *PiQeD* (triliteral).

Binyanim and Mishkalim

It has been suggested that it may be helpful to discuss pattern structures with regard to specific word categories (Owens, 1997; Buccellati, 1997), for example, to consider verbs and nouns separately. In the following, the two word groups are described in some detail.

Binyanim

There are seven structural categories of Hebrew verbs, traditionally called *binyanim* (singular, *binyan* ‘construction’). These structures may be considered inflectional classes or patterns of conjugations (Aronoff, 1994; Berman, 1978). They are individually named by the forms they assume for the root P-ʾ-L, expressed as a verb in 3rd person masculine singular, past tense, which carries the core meaning of acting: *Pa’aL*, *niF’aL*, *Pi’eL*, *Pu’aL*, *hitPa’eL*, *hiF’il*, and *huF’aL*. For the purpose of clarification, root consonants are printed here in uppercase letters, vowels and affixes in lowercase, and the Hebrew pharyngeal ‘ayin is signified by an apostrophe (’), as in Table 1.1.

The seven verbal *binyanim* are presented in (9). The replacement of /p/ by /f/ is caused by spirantization (a phonetic phenomenon caused by transforming a plosive consonant into a fricative, a continuant sound); Cs stand for the root consonants; lowercase letters stand for either pattern’s vowels or pattern’s affixes, hyphens are added for clarification.

9. a. *pa’al*—CaCaC
- b. *ni-f’al*—ni-CCaC
- c. *hi-f’il*—hi-CCiC
- d. *hu-f’al*—hu-CCaC
- e. *pi’el*—CiCeC
- f. *pu’al*—CuCaC
- g. *hit-pa’el*—hit-CaCeC

Remember that the same verb can appear in more than one *binyan*, but the distribution of Hebrew verbs among the seven *binyanim* is not equal. I know of no statistics of such distribution in contemporary Hebrew, but with regard to Biblical Hebrew it was calculated (Aronoff, 1994) that in the five

major *binyanim*, 71% of the verbs occur in the first *binyan* (*pa'al*), 28% in the second (*nif'al*), 27% in *pi'el*, 32% in *hif'il*, and 11% in *hitpa'el* (the percentages exceed 100 because most roots appear in more than one *binyan*).

The following is an example of how the *binyan pi'el* is inflected, with the root K-M-C, which carries the general notion of 'being greedy' (hyphens are added to clarify the boundaries between the verb stem and the pattern affixes).

10. Past

<i>kimac-ti</i>	(1st mas./fem. sing.)	<i>kimac-nu</i>	(1st mas./fem. pl.)
<i>kimac-ta</i>	(2nd mas. sing.)	<i>kimac-t</i>	(2nd fem. sing.)
<i>kimac-tem</i>	(2nd mas. pl.)	<i>kimac-ten</i>	(2nd fem. pl.)
<i>kimec</i>	(3rd mas. sing.)	<i>kimc-a</i>	(3rd fem. sing.)
<i>kimc-u</i>	(3rd mas./fem. pl.)		

Present

<i>me-kamec</i>	(1st/2nd/3rd mas. sing.)	<i>me-kamec-et</i>	(1st/2nd/3rd fem. sing.)
<i>me-kamec-im</i>	(1st/2nd/3rd mas. pl.)	<i>me-kamec-ot</i>	(1st/2nd/3rd fem. pl.)

Future

<i>'a-kamec</i>	(1st mas./fem. pl.)		
<i>te-kamec</i>	(2nd mas. sing.)	<i>te-kamec-i</i>	(2nd fem. sing.)
<i>te-kamec-u</i>	(2nd mas./fem. pl.)	<i>ye-kamec-u</i>	(3rd mas./fem. pl.)
<i>ye-kamec</i>	(3rd mas. sing.)	<i>te-kamec</i>	(3rd fem. sing.)

Imperative

<i>kamec</i>	(mas. sing.)	<i>kamec-i</i>	(fem. sing.)
<i>kamec-u</i>	(mas. pl.)	<i>kamec-na</i>	(fem. pl.)

As can be seen in (10), past tense 3rd person masculine singular of *pi'el* may be seen as the unmarked form. It has no pattern affixes attached. It has no overt marking of person, number, and gender. Some gender distinctions are not realized and person markings are missing in the present tense.

The future tense of *pi'el* uses prefixes and suffixes, such as *te-kamec-i* 'you will be greedy' (1st fem. sing.). Present tense verbs are marked for gender and number only; they are neutral with regard to person. Consequently, present tense forms are no different from nouns specifying agents who perform the acts expressed by these verbs. For example, *šomer* 'guard' may mean "a guard" and also "he is guarding."

Verbs in Hebrew do not exist outside the *binyanim* system. Every verb is realized in one or more conjugation, but very few verbs feature in all seven. So each one of these *binyanim* accommodates a different selection of roots. Each *binyan* is a class of word patterns that vary in denoting person (first, second, third), number (singular, plural), gender (feminine, masculine), and tense (past, present, future). That makes about 30 different word forms in each *binyan*.

Importantly, the inflection system contains redundant elements across *binyanim*. For example, the suffix *-ti* is always used for marking first person singular in the past tense, and the prefix *ti-* is used as a first and third person marker in the future tense. Some derivational affixes (those distinguish between *binyanim*) appear in all forms of a certain *binyan* in a specific tense (e.g., *hit-* in past tense of the pattern *hit-Ca'eC* (*hitPa'eL*) or *ni-* in the past and present tense pattern of *ni-C'aC* (*niF'aL*). The invariance of affixations such as these enable us to view the *-ti*, the *-ni*, or the *hit-* as affixes that are separable from the verb pattern.

Verbal affixes that are specific to a certain *binyan* such as *hit-* or *ni-*, and nominal patterns (affixes) such as *mi-*, as in *mi-qlat*, are considered derivational affixes; they distinguish between unique classes of words that may have a semantic feature in common. Conjugation affixes such as *-ti* or *ti-* are inflectional; they characterize minor variations that mark gender, person, tense, and number by keeping strictly to the conventions of an inflectional paradigm. Inflectional affixes typically mark or change grammatical relationships, such as plural, tense, and possession, and are fairly automatic; derivational ones change the grammatical class of the words, so that the result of a derivational process is a new word. For example, *rakad* (verb) 'danced' (3rd fem. sing.); *rakd-an* (noun) 'dancer'.

In summary, we may define the verb's central components as the base or stem, which consists of the root and its co-articulated vocalic pattern, and the affixes, which are optionally placed before or after the stem, according to the form of inflection or the choice of *binyan*.

Imperatives

Imperatives are, of course, expressed only in *binyanim* that entertain active verbs; no imperatives are found in typically passive *binyanim* such as *pu'al* and *huf'al*. The imperative form is similar to the second person future conjugation with the prefix cut off (in *pa'al* and *pi'el*, but not in *hif'il*), together with occasional changes in the stem's vocalic pattern. For example, the imperative of *ti-kšor* 'you (mas. sing.) will tie' becomes *kšor!* 'tie!'; *te-šaber* 'you (mas. sing.) will smash' is *šaber!* 'smash!' (mas. sing.). *Taštil* 'you (mas. sing.) will implant' has the imperative *haštel!* 'implant!' (mas. sing.).

Infinitives

Hebrew infinitives are also close to future verb patterns, somewhat similarly to the imperatives. In some *binyanim* the infinitive appears as a prefixed future, 2nd person singular imperative, where the prefix is *le-* or *li-*. For example, the infinitive of 'to tie' (see the examples above) is *li-kšor*, and of 'to implant', *le-haštil*.

Syntactic and Semantic Aspects of Binyanim. The *binyanim* are conventionally taken to indicate several grammatical and semantic notions such as voice (active or passive), transitivity, causativity, reciprocity, and reflexivity. With many exceptions, *pa'al*, *pi'el*, and *hif'il* are regarded as active verb classes. *Pu'al* and *huf'al* are considered passive; *nif'al* appears as passive with some verbs, but active with others. In other semantic attributes of the *binyanim*, *nif'al* sometimes denotes a change of state. For example, compare *pa'al šaxav* 'was lying down' (describing a state), with *nif'al niškav* 'lay down' (change of state from standing/sitting to lying down). Another *binyan*, *pi'el*, connotes in many but not all cases an intensified, or repeated, form of *pa'al*. For example, compare *pa'al šavar* 'broke', with *pi'el šiber* 'smashed'. The seventh *binyan*, *hitpa'el*, can denote reflexivity, as in *hitlabeš* 'got dressed', inchoativity as in *hitrabu* 'proliferated', or reciprocity as in *hitvakxu* 'argued' (with each other). Finally, *hif'il* sometimes registers causation, as in *hišlim* 'made peace between rivals', or a change of state (inchoativity), as in *hichiv* 'became yellow'.

As noted, many exceptions exist to the semantic restrictions attributed to the *binyanim* by their core meaning, for example, *nif'al* verbs that are not passive (Schwarzwald, 1975; Berman, 1975a; Ornan, 1971a). Some hold that the number of verbs that do comply with semantic expectations suggested by the *binyan*'s pattern is not enough to comprise a majority (Bolzky, 1978, 1986; Ornan, 2003). Nevertheless, the semantic attributes of the *binyanim* are still effective when speakers produce new words in accordance with the form and core meaning of the *binyanim* (cf. Berman, 1975a, 1975b; Bolzky, 1982), even though the core meaning is not the only factor that affects the formation of novel words. Phonological considerations also seem to be of relevance (Bolzky, 1978; Sivan, 1963). For example, two *binyanim*, namely *pi'el* and *hitpa'el*, are more amenable for conjugating roots, having more than three consonants, derived from words not necessarily of Semitic origin, because the structure of their stems allows the incorporation of more consonants.

In my opinion, to deny any association between *binyanim* and core meanings is to commit two errors. First, psychologically, a tendency detected as a core characteristic of a group of items should not be disclaimed because of the exceptions to it. Theoretically, if, in a group of 100 items, 45 are identified as having a common trait and the remaining 55 items have indiscriminate, multiple traits, the 45 concordant items (although not a majority) still determine how this group is perceived; they are its stereotype. The feature qualifying the 45 items will become the default characteristic, and consequently, will be applied in word innovations even though it characterizes only a minority of the group's items.

Second, there is no reason why a certain *binyan* cannot have more than one criterion for inclusion. For example, a root may be generally realized in

nif'al either because it expresses passive voice or because it implies a change of state. *Hitpa'el* is expedient for at least three reasons (see above, and Berman, 1978). Speakers of Hebrew may keep in mind one or more criterion of the *binyan*'s core meaning, choosing the one most suitable for the context.

All in all, the *binyanim* as classes of verbal conjugations appear highly productive: They are semantically rich, structurally versatile, and parsimonious.

Mishkalim

The number of noun structures, *mishkalim* (singular *mishkal*), is not clear. One estimate puts the figure at more than 285, but the actual number may be far greater (Ornan, 1983a, 1983b, 2003). Schwarzwald (2002) estimated the number of *mishkalim* between 300 and 400. This, of course, depends on the criteria for counting *mishkalim*, that is, whether we count nonproductive ones—those that appear in one word only—as *mishkalim*.

Hebrew nouns and adjectives are traditionally classified into two groups: those that like verbs have roots in their stems, and those that do not. Those with roots normally share a core meaning with the verbs that realize these same ones. For example, the root Š-M-R could be realized in verbs to create *šamarti* 'I guarded', *nišmarti* 'I was guarded', or *šimarti* 'I preserved' or 'I conserved'. But this root can be also used to form the nouns *šomer* 'guard', *mišmar* 'guard duty', or *šimurim* 'conserved food'.

Ornan (1971a, 1971b) argued that a considerable number of Hebrew nouns have no roots, but rather, a combination of consonants and vowels. Some of which are either loan words or archaic, others appear in complex words, but not as independent forms. Examples for rootless words are *pinkas* 'notebook' and *mexiron* 'price list'. When the consonants of these words are extracted, what we get is a group of consonants (P, N, P, K, S and M, X, R, N) that are not semantically related to other words. On this view, the criterion for having a root is predicated on whether the word with the root in question has semantic link(s) with other words built with the same root.

Note however, that even a rootless word may be inflected, e.g., for number (plural = *pinkas-im*) or derived, as in *pinkas-an* 'one who does something with *pinkasim*'. As we have seen previously, derivations and inflections are not conditioned on having roots, they may be applied directly to word bases.

It should be pointed out, though, that the distinction between nouns that contain roots and those that do not has recently been queried for a different reason by other modern linguists (e.g., Berman, 1978; Ravid, 1990) who have demonstrated how "rootless" nouns may be conveniently inflected in

either a verb or a noun pattern, thus becoming root-nouns for all practical purposes. Theoretically, every noun may be recast in at least one of the existing noun patterns. For example, *šulxan* ‘table’ is traditionally considered as having no root. However, there is no reason why it may not be. The word *karnaf* ‘rhino’ has recently become a verb, so that one can say *hu hitkarnef* ‘he became insensitive’ (using rhino as a simile for bluntness). Once a rootless noun is recast in one of the *binyanim*, it is no longer rootless.

Ornan (1983a, 1983b, 2003) suggested a generative mechanism for transforming rootless nouns into root-nouns. First, he submitted, a rootless noun should be stripped of its vowels. Second, it should be cast in one of the *binyanim*, hence subject to the conjugations of that *binyan*. The number of consonants in the stripped noun will sometimes affect the type of *binyan* in which it may be cast. If it has three consonants it may be cast in every *binyan* because this is the ordinary number of consonants in a Semitic root. If the transformed noun consists of more than three consonants, it will be cast in either *pi’el* or *hitpa’el*. Roots with four (or even five) consonants cluster the middle slot open for a consonant in the Hebrew word pattern (see above). For example, the noun *telefon* ‘telephone’ after being stripped of its vowels (becoming T-L-F-N), is cast today in the *pi’el binyan*: *tilfanti* ‘I telephoned’. The word *balagan* (borrowed from Russian) is used in Modern Hebrew to connote ‘a mess’. After removal of the vowels it can be used by applying *hitpa’el* to form *hitbalgen* ‘he got into a mess’ (cf. Bolozky, 1982).

The gender for all nouns is determined as masculine or feminine. Animate nouns may have both forms, for example, *yeled* ‘boy’, *yalda* ‘girl’, but inanimate nouns are realized idiosyncratically in just one gender form. For example, *xulca* ‘shirt’ has only the feminine form; *pe* ‘mouth’ has just the masculine form. In terms of morphological marking of gender (and number: see above), and in contrast to the verbal patterns (*binyanim*), the marking of gender (and number) is in principle similar in all kinds of patterns (*mishkalim*). The masculine singular form is unmarked, but the feminine form is marked with a number of possible word endings (suffixes) *-a*, *-it*, *-et*, *-at*, or *-t*, as in *yald-a* ‘girl’, *dodan-it* ‘cousin’, *axyan-it* ‘niece’, *tarnegol-et* ‘hen’, *calax-at* ‘dish’, *yehudi-t* ‘Jewish’ (fem.). Some animate nouns do not distinguish male and female, for example, *nešer* (masc.) ‘eagle’ (either sex); in others there is a lexical difference between the sexes, for example, *zaxar* ‘male’, *nekeva* ‘female’; *gamal* ‘camel’ (mas.), *ne’aka* ‘camel’ (fem.).

With few exceptions, all nouns can be affixed to indicate number. In general, the masculine nouns (and adjectives) are suffixed with *-im*, as in *yelad-im* ‘boys’, and the feminine form is suffixed with *-ot*, as in *yelad-ot* ‘girls’. Mass nouns command only the plural form, for example, *mayim* ‘water’ or *taf* ‘toddlers’. Nouns can also be suffixed to mark possession, specifying the person and number of both the possessed item(s) and the possessor(s), as in *xulca-ti*

'my shirt', *xulcot-ay* 'my shirts', *xulcot-aynu* 'our shirts'. Note that both plural and possession suffixation sometimes entail vowel alternation (including vowel deletion) in the word base.

On the surface, then, nouns seem normally inflected for gender and number, and they are indeed presented in that way in recent books on Hebrew morphology (e.g., Schwarzwald, 2001, 2002). However, the amount of irregular affixation, together with unpredictable vowel alternation in the word's base in Hebrew noun inflection is so high that it becomes difficult to define the marking of gender and number as paradigmatic (uniformly rulelike), hence as inflection in the usual sense. Aronoff (1994) specifically pointed out that feminine singulars may have a number of different suffixes (*-a*, *-at*, *-et*, *-it*, *-ut*, *-t*, etc.) or none at all (thus appearing as masculine). In addition, there are approximately 80 masculine nouns in current use that take the plural suffix *-ot* instead of *-im*, and about 30 feminine nouns that take the *-im* instead of the *-ot* suffix. To complicate things even more, the irregular marking is not correlated with word patterns (*mishkalim*), so that there is no apparent grouping of irregulars in "families" (or "gangs") that have a common feature (Berent, Pinker, & Shimron, 1999).

Although some *mishkalim* have more irregulars than others, neither the gender of these nouns nor their plural suffix can be reliably determined from their surface form. Historically, plural marking as masculine or feminine was perhaps not a primary category, but depended on change in suffixation, and only later did this become associated with gender. Be it as it may, the irregularity of gender and number marking in Hebrew nouns prompted Aronoff (1994) to claim that "the *mishkalim* are not inflectional classes" (p. 131).

Now suppose we accept that the gender and number marking in *mishkalim* are not paradigmatic: Does this mean that turning singular nouns into plurals is no more than an idiosyncratic association of two lexical items? Psychologically, it seems, the answer is no! The experimental research presented in chapter 4 indicates that the crucial factor in terms of speakers' behavior is not whether gender and number inflection in Hebrew is paradigmatic, but whether number inflection is affected by automatic default procedure that reflects the general tendency to inflect masculine nouns with the *-im* and feminine nouns with the *-ot* suffix.

Considering the psycholinguistic data presented in chapter 4, the presence of a default noun inflection cannot be ruled out. Children mostly acquire the default procedure before they learn the irregularities. You will hear them saying *beycot* 'eggs' instead of *beycim* (Levy, 1980, 1982; Ravid, 1995). In an extensive study, Ravid (1995) showed that children remain faithful not only to the default procedure of plural inflection by affixation, they are also unaffected by vowel alternation when required in plural inflection. In addition, no research is needed to show that loan words acquire

plural forms in accordance with the default. For example, the plural of *televiziya* 'television' is *televiziyot*, whereas the plural of *telefon* 'telephone' is *telefonim*. Berent et al. (1999), Berent, Pinker, and Shimron (2002), and Vaknin (2000) suggested that number inflection of Hebrew nouns is automatically affected by the existence of a default procedure. Vaknin (2000), in fact, demonstrated that online inflection of irregulars slows it down, apparently because in those cases it conflicts with the normative association between singular and plural.

Productivity of Roots and Patterns Within Hebrew Nouns. The semantic relations among nouns with the same root are even more nebulous than those among verbs sharing the same root. Ordinarily, the common semantic feature is restricted to just one facet of the word's meaning (as in *kašarti* 'I tied', and *tikšoret* 'communication'). In some cases the semantic relation is more remote, and although it may be traced historically by etymologists it is not normally recognized by the contemporary Hebrew speaker (Ravid, 1990). In such cases the roots are polysemous, namely, words of different meaning share the same root.

As for the productivity of *mishkalim*, despite irregularities, several are still obviously productive. The *mishkalim* maCCeCa and miCCaCa are often used to form a noun that denotes a location where some activity is conducted or where objects can be found, for example, *maxbesa* 'laundry' or *mirpa'a* 'infirmary'. Yet they are also used in forming nouns without this core meaning, for example, *ma'atafa* 'envelope'. Similarly, the pattern CaCeCet is often used for naming diseases: *xacevet* 'measles', *'ademet* 'rubella', or *ša'elet* 'whooping cough', but also to form other nouns such as *cameret* 'treetop' or *rakevet* 'train'. The same may be said for the *mishkal* maCCeC, used for forming instrument-nouns such as *maghec* 'iron' or *mašpex* 'funnel'. Another *mishkal*, the pattern CaCiC, is used quite productively to form adjectives of the kind that end in the -able/-ible suffix in English. For example, *šavir* 'breakable' or *kari* 'legible'.

With respect to the relatively low productivity of the *mishkalim*, one should note the difference in the listing of verbs and nouns in most Hebrew dictionaries. Lexicographers apparently assume that the dictionary user knows the rules of inflection, so they traditionally entered verbs just once, in the past tense third person singular (nonaffixed) form; but they list nouns as individual words.

So, should we, as some linguists urge, deny that *mishkalim* are productive (Ornan, 1971a; Schwarzwald, 1975)? Once again, the answer lies in the criterion we set, which itself depends on what our interest is. If the criterion is whether we can infer meaning from a crossover between a root and a *mishkal*, then obviously, in some classes of words we may expect a large number of

wrong guesses. But if our concern is with the conceptualization and expectations of Hebrew speakers, we may be surprised to find that subjects do perceive some *mishkalim* as having a certain core meaning (Bolzky, 1999). Our choice of criterion should be guided by our interest in the different facets of language use. For example, if we assume that in the act of reading comprehension the reader automatically deciphers every bit of available printed information, we are likely to find that despite their relatively low productivity, *mishkalim* are taken into account by readers while constructing meaning from the text. If nothing else, the *mishkalim* are likely to be acknowledged for their syntactic roles as agents, instruments, objects, places, and so on. These distinguish them from other forms of speech and restrict syntactic and semantic processing.

This argument wins further support if we analyze several relatively productive *mishkalim* that characterize adjectives. For example, the *mishkal* CCaCi (or CaCCaCi, in four-consonant roots) is quite productive in denoting a nominal aspect. The adjective *šamran* 'conservative' can be inflected to produce *šamrani* 'conservativist'; *safa* 'language' may give birth to *sfati* 'linguistically'. These are manifestations of the very productive linear formation of an adjective by the addition of the suffix *-i*. Another productive adjective pattern ends with *-ut*; it is used, for example, for producing adjectives denoting a characteristic trait. From *'akšan* 'stubborn' we derive *'akšan-ut* 'stubbornness'; from *raxman* 'merciful' we derive *raxman-ut* 'mercifulness'. To be sure, there are many other abstract noun groups ending with *-ut* (cf. Bolzky & Schwarzwald, 1992).

In a dynamic language striving to satisfy modern needs and supply new forms of expressions, any kind of productivity, albeit often flawed because of irregularity, is still useful. For many linguistic purposes, low productivity is better than none; the information indicated by the *mishkal* may be valuable, and ambiguity may be resolved through context.

Another reason for considering *mishkalim* informationally expedient is suggested by Berman (1978, p. 408): The *mishkal* is an economical way of deriving the phonological structure of a Hebrew word in a regular and direct manner. As against a language where such patterns do not exist, it can facilitate articulation of and acquaintance with novel words. Such phonological structuring may well be crucial for reading also.

In chapter 4, we review the increasing evidence that lexical access in Hebrew involves decomposing verbs and nouns into their roots and patterns. If this is a reasonable proposition, the word's meaning can be extrapolated by extraction of its root and computation of the root's independent meaning, before its synthesis with the meaning of the word pattern. Accordingly, it should be easier to extract roots from familiar word patterns than from an endless list of patterns.

Adjectives

As indicated earlier, Hebrew nouns and Hebrew adjectives show a great deal of morphological similarity. Both types are suffixed to mark gender and number. The unmarked form of adjectives is the masculine singular. Like nouns, adjectives' suffixes that mark the feminine singular have the form *-a*, *-et*, or *-it*, and the plural forms of masculine and feminine suffixes are *-im* and *-ot*, respectively. For example, *gadol* 'big' (mas. sing.) becomes *gdol-a* when qualifying feminine nouns in the singular, and *gdol-im* and *gdol-ot* when qualifying masculine and feminine nouns respectively in the plural. The feminine form of *šaket* 'quiet' (mas. sing.) becomes *šketa* (fem. sing., marked with the suffix *-a*), the plural of the masculine singular is *šketim* (marked with the suffix *-im*), and the feminine plural form *šketot* (with the suffix *-ot*).

Unlike nouns, every adjective should have both a masculine and a feminine form, and their association with the feminine and plural markers is fully consistent with the grammatical gender, regardless of the singular's ending. For example, *'ir* (fem. irregular) *neqiy-a* 'clean city', *našim* (fem. irregular) *qatan-ot* 'little women', *xalon-ot* (mas. irregular) *gvoh-im* 'high windows'. Again, the plural form of the adjective is fully compatible with the grammatical gender of the singular. In fact, the best way a Hebrew speaker can remind himself or herself of the grammatical gender of a noun is by recalling the form of the adjective attached to it.

Like verbs and nouns, suffixes added to adjectives may entail changes in the vocalic pattern of the unmarked form. This vowel alternation often assumes the form of vowel deletion, as previously shown in *gadol-gdola*.

Many adjectives share a root with verbs and nouns. Some are derived from passive of verbs belonging to the *binyanim pa'al*, *hif'il*, and *pi'el*. For example, the root G-M-R, from which the verb *gamarti* 'I finished' and the noun *gmar* 'finish, completion' are derived, is also used to produce the adjective *gamur* 'is finished' or 'is consumed', *mugmar* 'is accomplished', and *megumar* 'is completed'. Some adjectives are cast in the third person present tense of some verbs. For example, the root R-G-Š, which is used to form the verb *hirgiš* 'he felt', also produces the adjectives *nirgaš* 'is excited' and *merageš* 'exciting'.

Adjectives also derive from nouns. Perhaps the simplest transformation of a noun into an adjective is accomplished through the suffixation of *-i* or *-it* to the masculine and feminine singular forms respectively. From the noun *cava* 'army' we derive *cva'i* (mas. sing.) or *cvait* (fem. sing.) 'militarily'; *cva-i-yim* and *cva-i-yot* for the masculine and feminine plural forms respectively. Some nouns are transformed into adjectives by adding the suffix *-ni*. For example, *kol* 'voice' becomes *kola-ni* 'vociferous' (mas. sing.), and may then be marked for gender and number to produce *kolan-it* (fem. sing.) as

well as *kola-ni-yim* and *kola-ni-yot*, in the masculine and the feminine plural forms respectively.

Many adjectives are formed from roots cast in the same *mishkalim* used for forming nouns. For example, the *mishkal* CaCCan is used to form the noun *šamr-an* ‘conservative’ from the root Š-M-R. But it is also used to form the adjective *kapdan* ‘meticulous’ with the root K-P-D. Admittedly, these examples demonstrate the fuzzy border between nouns and adjectives, as *kapdan* may be also used as a noun.

Adverbs

Although Biblical Hebrew contains a number of adverbs (e.g., *pit’om* ‘suddenly’), Hebrew does not enjoy such a simple procedure as, say, English, where adverbs are easily derived; for example, “ready” ⇒ “readily.” Occasionally, nouns are combined with prepositions to form adverbs. For example, by combining *kalut* ‘ease’ with the preposition *be-* ‘in’ we get *bekalut*—‘easily’, literally ‘with ease’. This procedure is in fact so productive that even adverbs drawn from Biblical Hebrew, such as *pit’om* mentioned earlier, are more often used together with the preposition *be-*; for example, *be-fit’omiyut* (literally, ‘with suddenness’). Another form of producing adverbs in Modern Hebrew is by combining words such as *ofen* ‘a manner of’ or *cura* ‘a form of’ with the preposition *be-* and coupling these with nouns. For example, ‘beautifully’ can be *be’ofen yafe* or *becura yafa* (literally ‘in a nice manner’, ‘in a nice form’).

Possessives and Constructs

The common word used to express possession in Hebrew is *šel* ‘of’. For example, *hakova šel hayeled* means ‘the hat of the boy’. In addition, the word *šel* may be suffixed to denote pronouns such as ‘mine’: *šel-i*, and ‘ours’: *šel-anu*. ‘The hat is mine’ is *hakova šel-i*, and ‘the hat is ours’ is *hakova šel-anu*. The form ‘yours’ is also inflected to mark gender and number: *šel-ax* (fem. sing.), *šel-xa* (mas. sing.), *šel-axen* (fem. pl.), and *šel-axem* (mas. pl.); as well as person: ‘his’, ‘hers’, and ‘theirs’ in feminine and masculine forms is *šel-o* (mas. sing.), *šel-a* (fem. sing.), *šel-ahem* (mas. pl.), and *šel-ahen* (fem. pl.) respectively.

Similarly, Hebrew also permits appending suffixes of possession directly onto nouns: One can say *kova’i* and *kova’axa* to denote ‘my hat’ and ‘your hat’ respectively. Moreover, when inflecting nouns to mark possession, one can specify singularity and plurality of the possessed objects so that *šulxani* is ‘my desk’ and *šulxanotai* is ‘my desks’. Such usage is characteristic of higher, usually literary, registers.

Hebrew constructs have some special features. Contrary to English, the qualifying noun follows the qualified noun. “Mountain road” is *derex harim* ‘road mountains’ (= mountain roads). The qualified noun is often changed at its end. This is particularly so with feminine endings. For example, *šmura* ‘reserve’ when qualified, say, as ‘mountain reserve’ is *šmurat harim*. When nouns do not have a feminine ending, the masculine singular remains unmarked but the plural form assumes a construct ending. For example, “forest boy” is *yeled* ‘boy’ *ya’ar* ‘forest’, but “forest boys” is *yald-ey ya’ar*. Note the change in the vowel pattern and affixation.

Nonpattern Affixes

In addition to affixes that may be defined as pattern elements, as we saw in (4) and (5), in Hebrew another kind of affix exists that cannot be seen as part of the word’s affixal pattern. These affixes play the role of function words, for example, determinatives, as in *ha-yeled* ‘the boy’, conjunctives, as in *ve-ha-yeled* ‘and the boy’, and a host of others. They are the equivalents of the English “to,” “from,” “into,” “like,” “this/that,” and “when,” as can be seen in (9) (hyphens are inserted to mark syllable boundaries).

9. a. *ha-yalda halxa la-xanut* ‘the girl went to (the) store’
- b. *ha-yeled yaca me-ha-xeder* ‘the boy went out from the room’
- c. *kše-ha-yeled halax* ‘when the boy went’

These affixes are obviously optional. All the affixes that play the role of function words may be also expressed by independent function words. Hebrew speakers may choose between using function words as external (nonpattern) affixes or as independent words.

Finally, although pattern affixes in verbs are highly productive (e.g., the suffix *-ti* always stands for first person in past tense, the prefix *-ti* marks second and third person in future tense), pattern affixes in nouns are much less productive (see below). Yet the distinction seems methodologically useful, for it highlights the underlying Hebrew word structure as well as the mechanism for word formation (cf. Bolozky, 1999).

To illustrate the entire array of word elements in Hebrew, Fig. 2.1 shows how Hebrew word components are related to each other according to a view

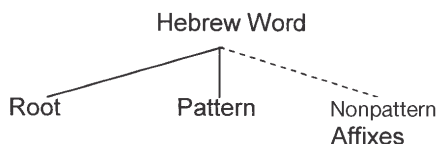


FIG. 2.1. A “flat,” “root and pattern” view of a Hebrew word.

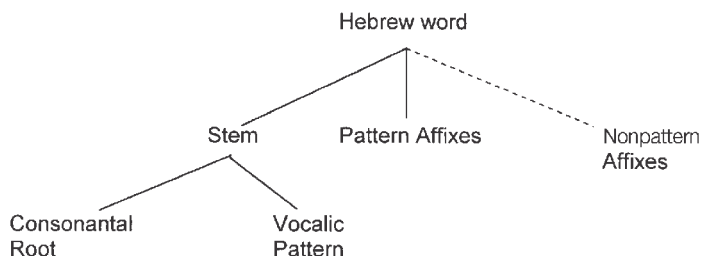


FIG. 2.2. A “deep” morphological analysis of the Hebrew word.

that contains the root and the pattern as the only two components of the Hebrew word. Figure 2.2 suggests a structure of Hebrew word as a combination of a stem and pattern-affixes, where the stem is a combination of the consonantal root and the vocalic pattern that is co-articulated with it. The optional, nonpattern affixes, which play the role of function words, are connected to the word structure by a broken line in both diagrams.

Note that for the sake of simplicity, the category “Pattern Affixes” in Fig. 2.2 consists of both inflectional (e.g., number marking) and derivational affixes.

Also note that in some instances the border between pattern affixes and a stem becomes blurred in the ongoing process of language development. One instance of this is secondary roots. For example, the word *mispar* ‘number’ can be thought of as a combination of the prefix *mi-* and the stem *spar*, which itself is a product of combining the root S-P-R with the vocalic pattern *-a-*. However, the *m* of the prefix *mi* has joined the root radicals S, P, R, to produce a quadrilateral secondary root, M-S-P-R, with which, as a new root, a new line of words is formed, such as the *pi’el* verb *misper* ‘numbered’ (3rd sing. past). Further discussion and more examples of this phenomenon are to be found in Bolozy (1999, pp. 13–14).

Further Reading

Comprehensive reviews of word formation in Modern Hebrew are provided by Berman (1978), Bolozy (1999), Glinert (1989, 1991/1994), Ornan (2003), Ravid (1990, 1995), Rosen (1966, 1977), and Schwarzwald (2001, 2002). The reader is also advised to consult Ornan’s 1971b article on Hebrew grammar in the *Encyclopaedia Judaica*. A number of papers published by Berman (1980, 1981a, 1981b, 1985) and Bolozy (1978, 1982, 1986) may also be consulted. A comparative approach in an insightful chapter on Hebrew morphology can be found in Aronoff (1994). For a somewhat challenging orientation the reader is referred to Bat-El (1989). For systematic presentations of Hebrew morphology written in Hebrew, see Blau (1972),

Goshen-Gottstein, Livne, and Shapan (1979), Ornan (1963, 1983a, 1983b, 2003), and Schwarzwald (2001, 2002). For a complete list of Hebrew verbs and nouns in paradigmatic tables, see Barkali (1964a, 1964b), and for a selection of 501 Hebrew verbs together with their inflections see Bolozky (1996). Extensive bibliography on research on the Hebrew language is provided by Waldman (1989).

3

Decoding Hebrew Words

READING TWO ORTHOGRAPHIES

The odd thing about reading contemporary Hebrew (and Arabic) is that skilled readers can read two orthographies more or less equally well. One orthography contains vowel signs in the form of diacritics (*nekudot* ‘points’), hence it represents all phonemes (the minimal units that represent speech sound of a language), in fact, with some redundancy. The other specifies few, if any, vowel signs, and most consonants. In this chapter we look at the psychological implications of reading with the complete or partial phonological information given by the two orthographies. We also check if different reading strategies can be applied to reading each of them.

Vowel signs, as a source of phonological information, are sometimes critical for Hebrew word recognition. However, vowel letters and vowel signs in the form of diacritical marks facilitate reading in some conditions, but in others they play hardly any or no part at all. The difference between reading voweled and the unvoweled orthographies depends on the extent to which top-down as against bottom-up information is processed. The former means extracting information from knowing the whole word whereas the latter means extracting information from letters and vowel signs. As will become clear in the following, I believe that the two kinds of processing are at work simultaneously, and readers adjust the volume of traffic on each processing route according to the kind of orthography they read.

People born in Israel, the “Hebrew natives” who hear Hebrew from day one and are literate in Hebrew as their first language, find reading and writing words with no vowel signs natural, efficient, and in most cases problem-free. If a text such as a newspaper, a novel, or official correspondence—the

stuff we read most—suddenly contained a complete set of vowel signs, my guess is that it would be a surprise for this population. They would see it bizarre, perhaps presumptuous (some ads in Israel actually use vowel signs as attention-getters).

For cognitive psychologists, however, this is an experimental windfall. It is an opportunity to examine the role of vowel signs in reading Hebrew, perhaps in other alphabets as well. As vowel signs provide phonological information, we may be able to learn about the general role of phonological information in reading. This is because Hebrew readers, as we saw, are equally proficient in reading voweled and unvoweled words. By comparing their reading ability with orthography with much phonological information missing, with their ability to read the fully phonological orthography, we can gauge the value of phonological information in reading, while taking advantage of optimal control for individual differences.

Such an experiment in reading Hebrew may help us answer a few questions: Why was complete vowel signification appended to the Hebrew writing system only about a millennium and a half after the Greeks adopted the Phoenician writing system and introduced a complete set of vowel letters? Why did Hebrew literates not perfect their writing system by utilizing the “vowel letters” option—just as the Greeks did with theirs? Moreover, how is it that even after the introduction of complete Hebrew vowelization with the invention of diacritical marks during the 9th century CE, unvowelized writing continues to serve Hebrew speakers to this day, and in fact is the primary way of reading contemporary Hebrew?

In this chapter I attempt to answer these questions by reviewing the experimental data collected on the role of vowel signs in reading Hebrew. For the convenience of English-speaking readers I start the discussion of the role of vowels in Hebrew by recalling their role in English.

The General Role of Vowels

Without doubt, an alphabet that includes vowel signs represents the phonemic structure of the language more completely. But how deep and exhaustive should this representation be in an optimal writing system? Although some writing systems are quite faithful to the phonetic pronunciation (e.g., Serbo-Croatian or Hangul: Feldman & Turvey, 1983; Taylor, 1980), no system of writing represents all discernible differences of speech. Compare how the character S sounds in *cats* and *dogs*. The first s sounds like /s/, the second, like /z/; the two are variants of the phoneme /s/, and referred to as allophones. Alphabets represent spoken languages **schematically**, with no intention (or capability) of representing every possible phonetic variation (cf. Liberman, 1989, p. 201). Word sounds are decomposed into phonemes, so that distinguishable phonemes or phoneme-clusters can be represented by

graphemes standing for letters and letter clusters. However, the relationship between letters and sounds is not necessarily one-to-one. Each letter may represent a set of different sounds, and in many writing systems some letters actually do so.

In the following, we see that vowels and consonants may not be equally important in facilitating reading. Practically, in an abbreviated, more economical version of a writing system that currently uses vowels (such as the English alphabet), the vowels as a group could perhaps be disposed of without much loss (but see a reservation below). Adams (1981) elaborated this idea, pointing out, for example, that most people have little trouble reading the following sentence when told that the vowels have been omitted: TH BSC DMNSTRTN THT THS TXT S STLL MR R LSS LGBL WHN TH VWLS HV BN RMVD.

Shorthand systems (stenographies) in many languages (e.g., Pitman and Gregg in English) shorten writing by clustering consonants and deleting vowels (Smith & Pattison, 1980). Where vowels appear at all, they are added in the form of hooks and loops to the end of a consonant stroke. The analogy between these inventions and unvoiced Hebrew seems undeniable. Significantly, the Greeks, who, as we have observed, were the first to supplement the Semitic alphabet with a complete set of vowel letters, were also the first to invent stenography that omit vowels (Glatte, 1959).

Multiple writing systems for reading in one language exist, not just in the alphabetic system. Japanese and Korean writing blends syllabic and logographic elements, in flexible proportions apparently adjustable to the needs of both reader and writer (Taylor, 1980). In learning to read, young Japanese learn the syllabic Kana, and are only gradually introduced to the logographic Kanji. The more skilled the reader, the more logographic characters he or she can read and write. Different modes of writing are therefore used for different audiences. This is happening in Israel today. Children learning to read begin with voiced words. Only in third grade are they gradually introduced to unvoiced words. In general, voiced and unvoiced writing systems may involve trade-offs between ease of reading and ease of writing, and this may account for the survival of both types of system in practice.

The Problematic Perception of Vowels in Speech

Although we focus here on the role of vowels in reading, it seems also instructive to consider how vowels are perceived in speech. As is pointed out later, most researchers of reading agree that phonological recoding—translating letters to phonemes—affects recognition of the written word (Frost, 1998; Perfetti & Sandak, 2000; Perfetti, Zhang, & Berent, 1992; Share, 1995). But the importance of recoding vowels may be less beneficial than recoding consonants.

Acoustically, what distinguishes vowels from most consonants is that most consonants are relatively briefer. Moreover, vowels tend to shade into each other, and immediate perception of adjacent vowels is more nearly continuous than categorical (Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967). Vowel identification is also a problem because in normal speech, at least in English, vowels are often neutralized to some extent, namely, the acoustic differences between vowels are minimized. Also, whereas stressed vowel errors account for only 4.1% of all errors in speech perception, unstressed vowels become more similar to each other (Lindblum & Studdert-Kennedy, 1967). The listener must then depend on context to facilitate vowel identification.

Finally, as suggested by B. Repp (personal communication, 1990), consonants may be more distinctive than vowels because of basic acoustic differences. The quick dynamic frequency changes that characterize most consonants may well be more noticeable than the slower changes of the vowels. Paradoxically, the short durations of consonants may be to their advantage: The fast changes that signal consonants may be so difficult to hold in auditory memory that they require rapid recoding into a more permanent form, perhaps by a specialized mechanism. So in spite of their apparent auditory accessibility, vowels may be less strongly represented in the phonological lexicon.

Among speakers of English, the vowels vary most markedly with regional accents, for example, the word *HEAD*, which sounds like /hed/, /haid/, /heeyud/, /hey-ed/, and so on, although within dialects vowels are systematically distinguished. Stemberger (1995) noted that words that differ on their vowels are confusable, hence are more susceptible to substitution errors in speech production than words that differ on a consonant. Most irregular words in English differ from their bases on their vowels (e.g., *find–found*, *mouse–mice*), whereas regular words invariably differ from their base only on their final consonant (e.g., *rat–rats*, *thank–thanked*).

Incidentally, some nonhuman primates can make vowel-like sounds, but cannot articulate consonants. Consonants, so to speak, may be “the true elements of human speech.” As human beings we are endowed with special abilities for producing and identifying consonants. We are more sensitive to their sounds.

From the vantage point of speech production, fast whispering seems to be the closest thing to script without vowels. Yet it can be very clearly understood. Also, in a study of speech disorder, Williams and Seaver (1986) showed that in single-word naming by Broca’s aphasics, whose speech production was judged by speech-language pathologists as “labored,” the prolongation of their speech was particularly marked for vowels (cf. Wertz, LaPointe, & Rosenbek, 1984). Remember that unlike the production of vowels, which is achieved by changing the shape of the vocal tract, the production of consonants is achieved by closing or narrowing the air stream while speaking. Williams and

Seaver suggested that the relatively extended length of vowel sounds (compared with consonant sounds) results from the low level of tactile feedback during vowel production. Their account, quite compatible with the motor theory of speech perception (e.g., Liberman et al., 1967; Liberman & Mattingly, 1985), provides a causal link between humans' lower sensitivity to the sound of vowels and the mechanics of vowel production.

In summary, the evidence from speech perception suggests that vowels may be less reliably perceived than most consonants. Reading is facilitated by correspondences between graphemes (letters or letter clusters that are associated with phonemes) and speech representations: phonemes, words, or intermediate sublexical units (Frost, 1998; Perfetti, Zhang, & Berent, 1992; Share, 1995; Seidenberg & McClelland, 1989; Van Orden, Pennington, & Stone, 1990). Vowels may accordingly be less important than consonants for recognizing words.

Finally, new empirical evidence (Berent & Perfetti, 1995; Lee, Rayner, & Pollatsek, 2001) seems to suggest that consonants and vowels are differently processed. The evidence suggests different processing stages of consonants and vowels in the very early stage of word recognition, indicating that consonants are recognized earlier than vowels.

Roles for Vowels in Reading and Writing

Liberman, Shankweiler, Orlando, Harris, and Berti (1971) showed that early orthographic representations are less likely to contain vowels than consonants because vowels have more variable grapheme–phoneme correspondences. Hence factors in the perception of speech may also contribute to the reduced importance of vowels in writing.

Adams (1981, 1990) pointed out that although the six primary vowels comprise roughly 39% of the letters in English texts, they are relatively uninformative. In English orthography the proportion of vowel letters to vowel phonemes is about 1:3, compared with 2:3 for consonants, namely vowels play a disproportionately large role in English spelling–sound irregularities. Indeed, Miller and Friedman (1957) showed that readers could regenerate texts with almost perfect accuracy when all vowels were removed. But when a similar proportion of random letters was removed, reconstruction accuracy dropped to a low of 20%. From this evidence Adams observed that a well-designed English alphabet ought to include either more vowels or none at all (like the unvoveled Hebrew, perhaps).

Special Roles for Vowels in Reading. Despite the foregoing, several researchers of reading in English have proposed that the vowels in alphabetic writing may play important roles. Venezky (1970, 1979) suggested that several vowel letters assume a second role as “markers.” These are graphemes that are not translated into phonemes, but have other roles, one being to

designate (mark) one option of grapheme-to-phoneme correspondence. For example, E in RACE is not translated into a phoneme but marks the pronunciation of the A and the C, both of which have more than one pronunciation in English. Consonants too are used as markers (e.g., K in PICNICKING marks the pronunciation of the second C), yet vowels seem to be more active in this role. The vowels *a*, *e*, *i*, *o*, *u*, and *y* occurring before a single consonant letter are pronounced as long vowels if the consonant is followed by a vowel; otherwise they are short (e.g., ROBE vs. ROB). The same rule dictates the doubling of final consonants before suffixes with vowels are added, for example, RUN and SWIM. The vowels *e*, *i*, and *y* appearing after C (and occasionally G) mark its soft pronunciation.

In many cases, English vowels, like their Hebrew counterparts (see following), disambiguate homophones, for example, in pairs like SEE–SEA, BLUE–BLEW, PLAIN–PLANE, and SUN–SON.

In an attempt to identify the positive role of vowels, Adams (1981, 1990) suggested that their primary function in contemporary English texts is to preserve the syllable as a perceptual unit, and thus facilitate reading, independently of any contribution of vowel signs to phonemic processing. Recognizing a word, particularly a long word, presumably involves syllabic parsing (Mewhort & Campbell, 1981), so as vowels tend to be located in the middle of most syllables, a good rule of thumb in reading is to identify every nonadjacent vowel in left-to-right scanning as indicating a new syllable.

Adams' suggestion is supported by Spoehr and Smith (1973, 1975) and Smith and Spoehr (1974), who proposed the existence of a higher order perceptual unit, called the **vocalic center group** (VCG). In orthography, the VCG is defined as a single vocalic element, consisting of a vowel or a diphthong preceded and/or followed by a consonant or consonants. The VCG is a unit of pronunciation. Spoehr and Smith (1975) suggested that when a letter string is presented, each individual letter is analyzed and identified. Then follows an orthographically dependent unitization stage, which parses the string into VCGs. These units are assigned an acoustic or articulatory code by a translation stage in the form of a program that can generate overt or covert speech. The functional value of the VCG units is that they reduce the number of units that must be translated. They thereby increase the probability that all processing will be completed under conditions of brief presentation. The contribution of vowels according to this proposal is thus to facilitate perceptual accuracy. Essentially, this function is the reading counterpart of the role assigned to syllables in speech by Liberman et al. (1967) (but see Coltheart, 1978). Note, however, that in this role, it is not the exact identity of the vowels that facilitates reading, but their mere existence in a certain location inside the written word.

Vowels may also play a role in reading monosyllabic words. Glushko (1979) claimed that in many words consisting of multiletter units (see be-

low), vowels have an important function in phonological processing. Multi-letter, sublexical units take the form of a vowel (or a vowel cluster) and a consonant (or a consonant cluster), for example, "... EAM" or "... EAT," as in BEAM and GREAT. These units were later termed the "bodies" of the words (e.g., Kay & Bishop, 1987). Treiman and Chafetz (1987) suggested that spoken syllables have a hierarchical rather than a linear internal structure. The syllable consists of an "onset" (initial consonant or a consonant cluster) and a "rime" (vowel and any following consonant). An onset need not necessarily be present in syllables (e.g., IT), but the rime is obligatory. Treiman (1986) and Treiman and Chafetz (1987) found that subjects tended to keep onsets and rimes intact in syllabic analysis of words.

If indeed onsets and rimes (or bodies) are psychologically real, vowels may play a role in reading English (and perhaps other languages) in marking the boundary between the onset and the rime (or of the beginning of a body). They thereby facilitate the parsing of the syllable into its units, although here again it is not the exact identity of the vowels that facilitates reading, but their mere existence in a certain location inside the written word.

Nevertheless, it seems likely that in the identification of syllables a parsing mechanism is assumed to take a letter string and systematically breaks it down into syllables, and perhaps further into syllable constituents of the type discussed earlier. Identifying syllables or other sublexical elements is valuable to the extent that they approximate (or correspond to) the representation of speech elements in memory—a representation that can be used as an access code en route to word recognition.

However, several researchers have criticized the view that vowels function as syllable markers facilitating syllable identification. Coltheart (1978) showed that syllabic parsing, as suggested by Hansen and Rodgers (1973) and Spoehr and Smith (1973, 1975), runs into trouble with several types of words. It fails, for example, in words that contain a sequence of two vowels that correspond to two phonemes (e.g., CHAOS, DUAL). By the parsing rules such words should be parsed as monosyllabic. The parsing rules also fail on all words ending in a "silent e." Coltheart cited words that are regular at the grapheme–phoneme level but are given incorrect phonological representations by a procedure that treats the VCG (actually, the syllable) as an indivisible unit, or by a procedure that treats each syllable independently of other syllables in the same word. He also pointed out that a syllabic approach to word recognition is difficult to reconcile with our ability to pronounce nonwords, with the symptoms of surface dyslexia, and with differences observed in subjects' responses to regular words and to exceptions.

In response to such criticism, it may be suggested that the syllabic parsing approach to word recognition can be buttressed with backup mechanisms or secondary processes that employ additional strategies for syllable parsing. Also, Adams (1981) argued that the syllabic approach is one of several rou-

tines of word recognition, so that it does not have to carry the entire burden of word recognition alone. The alternative model for word recognition offered by Coltheart (the context-sensitive grapheme-to-phoneme correspondence—GPC) seems to have its own shortcomings (cf. Van Orden et al., 1990).

A more fundamental and damaging criticism of the syllabic approach to word recognition, however, holds that parsing syllables is simply gratuitous. Seidenberg (1987) and Seidenberg and McClelland (1989) reserved no role for vowels as syllabic markers simply because in their model of word recognition no parsing is necessary. Seidenberg (1987) and Jared and Seidenberg (1990) directly addressed the issue of syllabic parsing by using two different experimental paradigms. Following Adams (1981), Seidenberg suggested that sublexical units reflect coalitions of letters (syllables or other clusters) that have been mutually reinforced in past activations. “These coalitions typically correspond to units such as syllables” (1987, p. 259). But not always. Syllabic effects “may derive from orthographic and phonological properties correlated with syllables, not syllabification procedures per se” (Jared & Seidenberg, 1990, p. 103).

If Seidenberg and McClelland are right, and letter coalitions due to past activations are all that is needed for word recognition, this should greatly curtail the unique role of vowels. After all, letter coalitions can be formed by consonants alone (similar to unvoweled Hebrew).

Shortly we see in detail that Hebrew readers can indeed read words with no vowel signs at all (though Hebrew words can be parsed into syllables). Unvoweled Hebrew writing provides no indication of a word’s syllabic boundaries. Yet reading this alphabet is not seriously hampered (if at all) when vowel signs are lacking. Once again, we approach the view that vowels may well be superfluous.

An alternative writing without vowels, however, is unlikely to be equally feasible in different languages. Compared with Hebrew, English seems to be less amenable to consonant-only writing. For one thing, whereas the number of consonants in one cluster in Hebrew is normally no more than two, the number in one cluster in English may be up to four or more. Because English also allows multisyllabic words, the parsing of long words consisting of several syllables that include consonant clusters is likely to be difficult without the aid of vowels. For another thing, as mentioned earlier, with short words, English depends heavily on close attention to long–short vowel distinctions such as CAP–CAPE, MAN–MANE, POP–POPE, BET–BEAT, and so on. Nonetheless, the significance of this reservation remains to be seen.

The Role of Vowels in Early Reading and Writing. Experimental research on the differential roles of vowels and consonants in early reading development is rather sparse. One study, by Fowler, Liberman, and Shank-

weiler (1977), demonstrated that children between the second and the fourth grade misread vowels more than consonants. Also, although they misread more consonants in the final position than in the initial position in a syllable, the position of the vowel within the syllable had no effect on the frequency at which it was misread. Finally, consonant errors were found to bear a close phonetic relationship to their target sounds, whereas errors in vowels were essentially unrelated, phonetically, to the vowel as written.

Other evidence comes from studies of inventive spelling (Bissex, 1980; Gentry, 1982; Read, 1971). When a preschooler brought up in a literate environment discovers the alphabetic principle—that speech sounds may be coded by graphemes—his or her attempt to write down a spoken utterance, without yet knowing the conventional spelling, is typically characterized by frequent omissions of vowels. Bissex reported that her son, Paul, mastered the writing of consonants first. Next he tended to insert a vowel in every syllable, as if he was using vowels as syllable-markers (see above), often using the same vowel letter to represent a variety of vowel sounds. Perhaps little Paul realized that consonants are more informative than vowels (cf. Feldman, 1978), or perhaps consonants were more prominent in his perception of speech elements.

More research is needed to evaluate these proposals. Still, the common thread of evidence regarding the role of vowels in Hebrew and in English is that unlike consonants, vowels have little value in immediate phonological processing. Whether they are more influential in other mechanisms of the reading process remains an open question.

Experimental Studies on the Role of Hebrew Vowels

Most of the studies reviewed in this section were originally designed as part of a general effort to detect the role of phonological processing in reading. Earlier we observed that the Hebrew language offers a unique way of investigating this issue. But enhanced phonological processing is just one possible contribution of vowels to reading. In reviewing the following studies, I have reframed and interpreted the data on vowels in Hebrew word recognition within the wider framework of the potential contributions of vowels to reading. I have made no attempt to survey the entire literature on phonological recoding in Hebrew; the studies discussed are what I found to be the most pertinent to the issue of the role of vowels in reading.

By determining the relative importance of Hebrew vowel signs in the processing of Hebrew words in general, the studies reported help to shed light on the existence of other possible roles for vowels during word recognition, apart from their obvious one of disambiguating homographs. Any such roles will, of course, be constrained by the degree to which, in reading a

word, one processes the phonemic values of its graphemes or other sublexical elements. This is a central controversy in the study of word recognition in every alphabet, although agreement now seems to be drawing closer (Frost, 1998; Perfetti et al., 1992; Van Orden et al., 1990). In the debate on this issue three general positions may be identified.

According to one approach, the reader recodes the grapheme pattern into a phonemic code, thereby identifying a word as if internally articulating or listening to it (e.g., Sperling, 1967; Spoehr, 1978). Another position assumes that the reader identifies a written word directly, by its visual features only, in the same way as one identifies other visual patterns such as road signs or punctuation marks (e.g., Fredriksen & Kroll, 1976; Smith, 1973). According to this suggestion, when people read aloud they retrieve phonemic values from memory only after the word itself has been identified by its visual features.

The third approach combines the preceding two by assuming parallel processing along “dual routes”: a direct, visual-to-meaning route (where “meaning” means all the knowledge associated with a word including syntactic role, spelling, and phonology) and an indirect, visual-to-sound-to-meaning route. The two processes are assumed to be activated simultaneously, and lexical access is achieved by whichever happens to be the faster under specific conditions (see McCusker, Hillinger, & Bias, 1981; Henderson, 1982, 1985a, 1985b; Humphreys & Evett, 1985; Patterson & Coltheart, 1987; Jackson & Coltheart, 2001).

The dual route theory of word recognition, in its present form, assumes that in the complex process of recognizing and comprehending a word, at least two major processes are at work. One process directly associates the visual appearance of the word as a whole with the representation of the word in the mental lexicon, then, through the links between the orthographic, phonological, and semantic stores, the word is understood and may be articulated. In other words, after the link between the printed word and the representation of the word in the mental lexicon is established, the word recognition process continues in a top-down direction. A second (indirect) process begins by associating the word’s graphemes (letters and letter clusters) with their phonological counterparts in the mental lexicon. Then, due to the similarity between the assembled phonemic information and the spoken word, and owing to the already established link between the sound of the word and its meaning, the word is recognized and comprehended. Essentially, this is a bottom-up process—beginning by recognition of the letters and the phonemes they represent, and ending with the word meaning.

The direct route must be assumed because the assembled phonological information never approaches a complete representation of the spoken word. Some information must be gleaned from our knowledge of the word as a

whole. The indirect route must be assumed in view of our ability to pronounce novel and nonce words, as well as evidence showing an association between phonological knowledge and speech difficulties on the one hand and reading difficulties on the other hand. There is also accumulated evidence indicating that phonological processing is performed automatically, following visual identification of the print (Berent & Perfetti, 1995; Lee, Rayner, & Pollatsek, 2001). The interactive theory of reading suggests that the two processes operate simultaneously and interactively, feeding and supporting each other.

Therefore, in the review and the following discussion the view taken here is that the “dual route” theory and “interactive models” of reading (simultaneous bottom-up and top-down processing) are not incompatible. The dual routes are treated here as simultaneous processing of lexical and sublexical units in top-down and bottom-up directions. As simultaneous processes, they are activated together, on the initial contact between the eye and the word. Furthermore, I do not consider either of them as a default procedure, or maintain that one route is faster than the other. My position is that word recognition is accomplished through the accumulation of bits of information derived from several sources in parallel (a more detailed discussion can be found in Seidenberg & McClelland, 1989; Van Orden et al., 1990; Carello, Turvey, & Lukatela, 1992; Besner, 1999). No source of information, in and of itself, need provide wholly adequate and unequivocal data for the execution of word recognition. Instead, data are accumulated from different sources until a certain threshold of activation is reached. Finally, linguistic units that are taken up by both routes, particularly by the bottom-up (assembly) operation, are not only letters and whole words. They may be any sublexical elements, such as morphemes, roots, patterns, word bases, stems, and other linguistic units, including recurrent orthographic clusters (cf. Glushko, 1979; Paap & Noel, 1991).

The Contribution of Vowel Signs to Phonological Processing

There is a particular difficulty in investigating phonological processing with most alphabets because manipulating phonological properties inevitably involves graphemic (visual) changes. Therefore, one can hardly obtain complete control of either factor. This, as said previously, is where Hebrew offers a unique experimental possibility. As the skilled Hebrew reader is equally acquainted with vowelized and unvowelized types of writing, effective control of individual differences and graphemic display is possible. The diacritical marks signifying vowels are small, appearing in the form of dots and short strokes below the printed line. They are easily separable from the main char-

acters that form the line of print. So one way to assess the contribution of phonological information to reading is simply to compare latency—speed of articulating a seen word in an experimental design known as “naming”; or distinguishing a word from a string of letters in an experimental design known as “lexical decision.” An error rate in reading the same word with and without vowels is also measured in these experiments. If voweled text is indeed easier to read, despite having a larger number of signs to be processed, this would suggest that phonological processing is instrumental in reading.

The Studies of Koriat

This rationale led Koriat (1984) to investigate word recognition in Hebrew, limiting his study to words with one reading (i.e., not homographs). In a lexical decision task, the subjects were required to distinguish between words and nonwords. The words were sometimes voweled and sometimes unvoweled. The effects of context and word length were also investigated. Koriat hypothesized that a context relevant to the given word should resolve phonological ambiguities, thus reducing the contribution of vowels. Also, the longer the letter string, the greater the advantage of vowelization should be. In his experiments target words (the words analyzed to test the research hypotheses) were preceded by semantically related words, semantically unrelated words, and nonwords. Word length varied from two to five (consonant) letters.

Only context yielded a significant main effect. There was no effect for vowelization or word length. The interactions between vowelization and either word length or context were also nonsignificant. Koriat concluded that, under the conditions of this experiment, vowel signs did not facilitate lexical access. With regard to the more general question of direct versus indirect recoding, his early findings add support to a direct visual-to-meaning model.

Koriat (1984) did find an advantage for vowelization in the pronunciation (naming) task, where, in an otherwise identical design, the subjects were required to pronounce the strings of letters. Here Koriat also found that both context and word length had a significant effect, although the interactions between vowelization and either word length or context were not significant. Koriat suggested that these findings, together with those outlined earlier, supported a dual-route, parallel-processing (“horse race”) theory: On the one hand, lexical access (the process of identifying a word in the mental lexicon, also referred to as word recognition) is fastest along the direct route, and is therefore not influenced by the availability of vowel signs. On the other hand, in a naming task, pronunciation is made faster with vowel signs because phonological processing is performed prelexically (i.e., before recognition of the word’s meaning) in the parallel indirect route, which although not used by lexical access, nevertheless provides useful information for the pronunciation mechanisms that must ultimately be activated.

In a second study, where word frequency, context, and word length were manipulated as independent variables, Koriat (1985) found that vowels enhanced word recognition even in a lexical decision task. Koriat suggested that the vowelization effect found in this later study resulted from adding low-frequency words to the word list. The effect of vowelization was in fact stronger for low-frequency than for high-frequency words, though reliable in both cases. Koriat maintained that with low-frequency words, subjects adopted a different strategy in word recognition, one heavily reliant on phonological processing. Hence they were aided by vowel signs. Because his word list contained a mix of low- and high-frequency words, subjects tended to use the strategy that best suited the former even with the latter. Obviously, this explanation would be more convincing if word frequency had been directly controlled in a proper experimental design.

The effect of context was also significant in this study. Remember that the theory of simultaneous parallel routes in word recognition (i.e., direct, visual-to-meaning, and indirect, graphemes-to-phonemes-to-meaning) predicts that context, which is related to general knowledge, should expedite semantic processing, which in turn should facilitate the direct visual-to-meaning route. Koriat found that word reading time indeed decreased when context was provided. Yet context shortened reading time for both vowelized and unvowelized words. The effect of context was additive to the effect of vowelization—contrary to the expectation that the contribution of vowel signs is made gratuitous where contextual hints are provided. Theories of phonological processing in word recognition need further elaboration to explain this puzzle (cf. Kay & Marcel, 1981).

The Studies of Navon and Shimron

Another experimental effort was conducted by David Navon and me. We studied the effect of vowelization in the recognition of words using several different paradigms. In one set of experiments (Navon & Shimron, 1981; Shimron & Navon, 1982) we compared naming latencies for three types of stimuli: (a) vowelized words, (b) unvowelized words, and (c) words printed with irregular vowelization, the correct vowel signs being replaced by incorrect signs that nevertheless preserved the appropriate phonemic values. This was possible owing to the redundancy of Hebrew vowel signs described earlier. The three modes of presentations and an additional one to be discussed later are shown here with the words *agas* 'pear' and *mecax* 'forehead':

- | | |
|--|-------------|
| a. Correct vowelization: | אָגָס מֵחָץ |
| b. No vowelization: | אגס מחץ |
| c. Wrong signs that preserve phonological value: | אֲגַס מֵחָץ |
| d. Wrong signs that do not preserve phonological values: | אֲגַס מֵחָץ |

University undergraduates as well as fourth-grade schoolchildren served as subjects. The words we used had only one correct reading each, even when unvoveled, so that their vowels provided no lexical information.

The children and the adults named the voveled words significantly faster than the unvoveled ones, consistent with the findings of Koriat (1984). Again, the advantage of the voveled words was realized even though the vowel signs might have required extra visual processing and did not deliver any more visual information needed to discriminate among familiar word patterns beyond the information available in the letter string proper. It seems reasonable (although not compelling) to assume that the locus of the beneficial effect of the vowel signs is in phonemic recoding. This finding is particularly interesting in view of the vast exposure of Hebrew readers to unvoveled texts. As the advantage of vowelization was manifested for both children and adults, we concluded that even extensive practice does not render vowelization superfluous. In a study measuring reading aloud accuracy, Ravid (1996) also found that adults benefited better than fourth graders from reading voveled words (cf. Ravid & Shlesinger, 2001).

The comparison of correctly voveled words with words misvoveled in a way that still preserved correct phonemic values is an indicator of the value of diacritical marks as visual features of the word pattern. We found that the adults were completely insensitive to graphemic changes as long as the phonological values were not distorted, but the children were not—the mere graphemic distortion retarded their naming latency. Children are expected to have mastered the two systems, but still read many voveled texts when they reach the fourth grade, thus it is understandable that their visual memory of the voveled word is stronger, as our data suggest.

Voluntary Control of Using Vowels in Phonological Processing

In the word-naming studies just mentioned (Navon & Shimron, 1981; Shimron & Navon, 1982), we also capitalized on specific properties of the Hebrew script to find out whether the translation of graphemes into their phonemic equivalents is subject to voluntary control. In other words, is it possible to focus successfully on the graphemic aspects of a word and avoid any phonemic processing, or is phonemic processing automatic? To study this question, we again exploited the fact that the skilled Hebrew reader is well trained in reading texts that are voveled or unvoveled. We selected words with only one unvoveled reading. In a between-subject design, the words were presented (see previous examples) (a) voveled, (b) unvoveled, (c) voveled in a way that was graphemically illegal but nevertheless mapped onto the same phonemic categories, and (d) voveled in a way that was illegal both graphemically and phonemically.

Three groups participated in this naming study. Each was presented with correctly vowelized words (a) and with either unvoveled words (b) or with phonemically distorted words in the ways specified above (c or d). They were told to disregard the vowel signs altogether. In addition, they were informed that although each word had a unique reading, the vowel signs were sometimes misleading. Hebrew readers should not have difficulty following such instructions because, as indicated earlier, they are all trained in reading words using consonant letters alone, and the letter string is perceptually separable from the vowel signs, which are located on a different horizontal layer.

The first group was presented with words of which half were vowelized correctly (a) and half were both graphemically and phonemically distorted (d). We reasoned that if phonemically incorrect vowel signs interfere with word naming, this may indicate that subjects cannot help but recode the vowel signs, and that this, in turn, interferes with lexical access or with response generation. To control for the possible effect of the absence of graphemic and phonemic information contained in the appropriate vowel signs, the second group of subjects read words that were either vowelized correctly (a) or not at all (b). To control for the possibility that incorrect vowelization introduces some incompatible visual cues, the third group read words that were either correctly vowelized (a), or graphemically, but not phonemically, distorted (c). Our subjects, again, were children and adults.

The results clearly showed phonemic interference. Both children and adults (the former to a higher degree) were significantly inhibited by phonemic distortions. The elimination of vowel signs had a small negative effect on the children but none on the adults. Mere graphemic distortion had no effect on the children and only a small one on the adults. All in all, the only effect that appeared strongly significant in both children and adults was phonemic distortion. This sensitivity to phonemic distortion, coupled with insensitivity to both elimination of vowels and mere graphemic distortion, led us to conclude that in most of the trials vowel signs were encoded, and that, in general, graphemes were automatically translated into phonemes.

Of course, this evidence does not allow us to determine the temporal locus or role of the grapheme-to-phoneme translation process. According to this study, the translation may occur before, after, or in tandem with lexical access. Still, the importance of this finding lies in its support for the existence of grapheme-to-phoneme translation in word naming. Although many phonemic interference effects might be accounted for by postlexical automatic activation of phonological features associated with the lexical entry, this finding cannot be interpreted in such a manner. Also, although some phonemic interference effects can be dismissed on the grounds that they apply to a "no" response in a lexical decision task, which is executed relatively late (Coltheart, 1978, p. 174), the present effect applies to word naming.

Our work just described (Navon & Shimron, 1981; Shimron & Navon, 1982) required subjects to utter the word presented. In a later study (Navon & Shimron, 1985), we tested the same hypotheses with two additional experimental designs, lexical decision and semantic decision, where subjects were not required to pronounce the words they read. This was called for because phonemic processing may be induced by articulatory processes more than by the normal type of silent reading.

In the lexical access experiment subjects were tested under the same set of conditions described above except that nonwords (random strings of letters) were inserted into the lists and subjects were asked to say “yes” if the letter string was a word and “no” if it was not.

In this task, absolutely no difference emerged between latencies of lexical decision for correctly vowelized and unvowelized words. There was a small, nonsignificant difference (14 ms) between correctly vowelized and graphemically distorted words. But a large, significant difference (about 40 ms) existed between correctly vowelized and phonemically distorted words.

So these results were consistent with those of our naming experiment (Navon & Shimron, 1981). Subjects were not hampered by the elimination of vowelization, were only slightly affected by mere graphemic distortion, but were clearly disturbed by phonemic distortion. These effects, therefore, cannot be wholly attributed to processes within a strict vocal-articulation route to word identification.

A lexical-decision task does not require pronunciation, but nor does it require processing for meaning. That is, in performing the experimental task subjects did not have to retrieve the meaning of the word from memory, but merely to recognize a group of letters as belonging to the known set of familiar words. Processing for meaning, of course, is inherent in normal reading. Therefore, we completed this series of studies with a semantic-decision experiment.

In this study (Navon & Shimron, 1985), we arranged the target words in eight categories of familiar nouns: *plants*, *animals*, *minerals*, *weather*, *clothing*, *household items*, *human features*, and *occupations*. The words were vowelized in the same four ways described in the naming experiment. Subjects were presented with a category title for a period of two seconds, then the target word appeared. The subject had to decide whether or not the word belonged to the category just presented. The decision was indicated by the subject's pressing a “yes” or a “no” button. Latency was measured from the presentation of the target word until the pressing of one of the buttons. In half of the trials the target word matched the category.

Using university students as subjects, we found a significant overall vowelization effect. On closer inspection we found that although the total difference in response time for correctly vowelized words and unvowelized words was practically nil, there were small, nonsignificant differences (10 ms) between cor-

rectly vowelized and graphemically distorted words, and a considerable difference (34 ms) between correctly vowelized and phonemically distorted words.

Even larger differences appeared with correct “yes” responses alone (30 ms between correctly vowelized and graphemically distorted words, and 51 ms between correctly vowelized and phonemically distorted words). The results in this semantic decision task, although weaker than in the naming and lexical decision tasks, still indicate a reliable phonemic effect.

The experimental paradigm devised by Navon and Shimron is considerably more sensitive than that used by Koriat in determining that phonological processing occurs during reading—not that such processing is necessarily beneficial. In our design, even for tasks where there was practically no difference between latencies of reading vowelized and unvowelized words, phonological processing could still be demonstrated by slower responses to distorted vowelization. Nevertheless, reaction to distorted vowelization is probably uncommon in normal reading. Considering just the positive contribution of vowel signs in our studies and in those of Koriat, the relative contribution of the phonological information given by vowel signs to the entire reading process of the skilled reader seems rather small. Still, as we pointed out (Shimron & Navon, 1982), it is greater for unskilled readers.

Context: The Limit of the Vowelization Effect

If the processing of vowels in reading single words is not entirely automated, it may perhaps be decreased or nullified under circumstances where phonemic information can be derived from sources other than the printed letters. One such source would be word context. In our later study (Navon & Shimron, 1985), we asked if phonological interference of the sort found earlier (Navon & Shimron, 1981) would still appear when the words were presented within context. We hypothesized that contextual cues may generate expectations for a certain word to appear. That word may enter short-term memory prior to the processing of its graphemes, thereby making the processing of vowels even more gratuitous. With context, then, reading would be sufficiently easy to render phonemic recoding unnecessary, and sufficiently fast to deprive interfering vowels of any effect.

In this experiment each target word, vowelized in the four ways described earlier, was preceded by other stimuli—a prime. The prime in this experiment was a content word presumed to be semantically associated with it in long-term memory, and to be capable of activating a semantic network in which the two words were neighboring constituents. Subjects were instructed to read the prime word silently and then to read the target word aloud. They were also instructed to ignore the vowels. Latency of naming the target word was the dependent variable.

The results showed no significant effect of vowelization. The correct vowels did not speed up reading and the incorrect vowels did not slow it down. Because normal text reading usually involves the formation of context, these results suggested that unvoveled normal text should take no longer to read than voveled text.

However, these results are not entirely consistent with those of Koriat (1984, 1985), described previously. He found that context significantly reduced the effect of vowels, but did not eliminate it altogether. The difference between the results of these studies may stem from their different procedures: Our experimental conditions (Navon & Shimron, 1985) strongly invited reliance on context and discouraged the processing of vowels as an aid to word recognition. Unlike in Koriat's experiment (1985), in ours there were neither nonwords nor unrelated primes in the list of stimuli. Words appeared in pairs in which they were always semantically related. Furthermore, our subjects were encouraged to ignore the vowels, and in any case, unlike in Koriat's studies, the vowels were sometimes misleading. On both accounts, then, in our study context was more likely to be utilized, and words were more likely to be accessed through a lexical route. Also, the presence of low frequency words in Koriat's (1985) target word list might have encouraged the processing of vowels in all words, and restricted the effect of context.

The Role of Vowels in Disambiguating Hebrew Homographs

The Studies of Bentin and Frost

We have noted that the Hebrew words used in the experiments reviewed had just one pronunciation when written unvoveled. Many Hebrew words, however, are homographs when unvoveled, namely, the same letter string has different pronunciations, and/or signifies different words or the same word in different morphological forms. For these words, vowel signs not only provide phonological information but also aid in disambiguating lexical meaning. This disambiguation seems to be the most important role of vowel signs in Hebrew.

Bentin and Frost (1987) presented subjects with a lexical decision task, using voveled and unvoveled stimuli. The words were homographic or nonhomographic. They were also divided into high- and low-frequency groups. The nonwords were regular nonwords, namely, letter strings that do not constitute Hebrew words, voveled or not, or words wrongly voveled.

With nonhomographic words mixed together with regular nonwords, Bentin and Frost's results were similar to those of Koriat (1984) and to ours (Navon & Shimron, 1985). The lexical decision latencies of voveled and unvoveled words were not significantly different. A significant word fre-

quency effect was found, but the interaction between vowelization and frequency was not significant. However, with homographs the unvoveled words were responded to significantly faster than were the voweled words. Again, high-frequency voweled homographs were responded to faster than low-frequency voweled homographs.

In addition, when nonhomographic and homographic voweled words were presented together with misvoweled words as nonwords, both types of words got a significantly slower response than when presented with regular nonwords. This finding seems quite predictable. When one reads a list of words, of which some are correctly voweled (or unvoveled) and others are wrongly voweled, one must pay extra attention to the vowels.

A second, naming, experiment yielded similar results with nonhomographic words. There was no reliable difference between voweled and unvoveled nonhomographic words. These results are not consistent with the results of our two experiments (Navon & Shimron, 1981; Shimron & Navon, 1982), or with Koriat's (1984). The reasons for this inconsistency are not clear, because of the many differences in the experimental conditions (e.g., word frequencies and the presence or absence of nonwords). As the contribution of vowels to word recognition is generally small, perhaps the demonstration of this contribution is highly dependent on experimental conditions. In any event, these findings of Bentin and Frost further support the general thesis suggested here, that the contribution of vowel signs in providing phonological information is quite limited.

With regard to the effect of vowels in reading homographic words, the naming of unvoveled high-frequency homographic words in Bentin and Frost's (1987) second experiment was at about the same speed as the naming of their respective voweled counterparts (no longer homographs). But the low-frequency unvoveled homographs were named significantly faster than their respective voweled counterparts.

Thus, both lexical decision latencies for unvoveled homographs and naming latencies for low-frequency unvoveled homographs were shorter than those of their voweled counterparts. Why should this be so? One would expect the disambiguation afforded by the vowels to speed up the reading of words that are homographs when unvoveled. The solution to this problem must take into account the specific experimental conditions in which these findings were obtained.

Word recognition in lexical decision tasks seems to be based on an incomplete process of lexical access. Processing may terminate when enough evidence has accumulated to suggest a word; definite lexical access is not required (cf. Seidenberg, 1990). The ordinary consonant string with its higher frequency of occurrence, higher than any individual lexical realizations, can act as a "strong coalition" (Seidenberg, 1987; Jared & Seidenberg, 1990) whose recognition time is expected to be shorter than any one of the

voweled alternatives (cf. Hogaboam & Perfetti, 1975; Niell, Hilliard, & Cooper, 1988; Frost, Feldman, & Katz, 1990). Vowels should yield no advantage, and may even be detrimental. Bentin and Frost suggested that vowel signs may actually cause task interference as they trigger unnecessary automatic word disambiguation processes.

In the naming task, where processing has to continue beyond the threshold of initial recognition, the further processing of unvoweled homograph strings leads to activation of the dominant (most frequent) lexical entry, which presumably can be named quicker than the other (less frequent) alternatives. By contrast, in naming low-frequency voweled homographs, the stimuli do not grant subjects the option of choosing their most dominant response, and any other response is likely to take longer.

This explanation, as intimated by Bentin and Frost, may also be recast in terms of response inhibition. If we accept that the word recognition process involves both excitatory and inhibitory processing (LaBerge & Samuels, 1974; Posner & Snyder, 1975; McClelland & Rumelhart, 1981; Rumelhart & McClelland, 1982; McClelland, 1987), more inhibition is likely to occur with voweled counterparts of homographs. That is, processing the vowels of an otherwise homographic (unvoweled) Hebrew word is likely to trigger inhibitory connections to other words that share the same consonant letters, but not the same vowel signs, particularly if the other alternative is more frequent. In reading the unvoweled homograph, in the absence of contextual cues, there is no basis for such inhibition. In such cases, the most frequent (or familiar, or most recently encountered) meaning is most likely processed without additional inhibitory processing. In the naming task this inhibitory process is perhaps responsible for the longer latencies of low-frequency voweled words that without vowels are homographs.

The appearance of inhibition with low-frequency words, which are normally processed relatively slowly, but not with high-frequency words, which are processed faster, is consistent with several studies (e.g., Stanovich & West, 1979). These show that inhibition increases when word processing is slower.

Note that according to all the interpretations offered only the processing of voweled homographs in some cases took longer than the processing of their unvoweled counterparts. In no case did correct vowelization impair the processing of nonhomographs. This should serve to emphasize the point that vowels have functions other than the mere acceleration of phonological processing. In fact, vowels are far more important for disambiguating homographs than they are for recognizing single words, as described earlier. For instance, in many Hebrew sentences printed without contextual cues, such as newspaper headlines without the subheadings, unvoweled homographs can create all kinds of ambiguities, making comprehension haphazard. Selective vowelization may be used to remedy this problem, as discussed earlier.

The Role of Vowel Letters in Phonological Recoding of Hebrew Words.

In a later study by Frost (1995) he examined the role of the Hebrew vowel letters, which, as described in chapters 1 and 6, are letters that have a dual function—as consonants and as vowels. In contemporary Hebrew they are mostly used for indicating the phonemes /i/, /o/, and /u/. Frost compared reading latencies of words in which vowel letters specified different amounts of vowelization, from zero to full vowel specification. In essence, he found that as with the diacritical marks in the studies of Navon and Shimron and of Koriat (see foregoing material), the amount of vowel specification by vowel letters was correlated with naming latencies. The more complete the vowel specification, the less time it took to name the words. Also, again as with the diacritical marks, the increased vowel specification was more effective in the naming task and less so in lexical decisions.

Summary

Quite clearly then, Hebrew readers are sensitive to every increment of phonological data contained in the print, and make good use of it according to the task's conditions and requirements. They need not hold strategic preferences in order to select either assembled or addressed phonology when the amounts of phonological data vary, because both assembled phonology and lexical knowledge are always available (or on standby). A switch from one strategy to the other is not needed.

Consequently, the definition of vowelized and unvowelized Hebrew orthographies as two completely different orthographies should be relaxed, and perhaps accommodate a continuum rather than a separate-categories approach. We should assume interim stages between the two extremes of completely vowelized and completely unvowelized words.

Within the interactive framework that assumes bottom-up and top-down processes to be operational at all times, the actual contribution of bottom-up prelexical (assembled phonology) on the one hand, or of top-down lexical (addressed phonology) on the other, varies, as explained earlier, according to input–output task conditions and requirements. We should expect relatively more top-down processing in reading unvowelized words and relatively more bottom-up processing in reading vowelized words. In either case, factors such as word frequency and contextual knowledge must also be considered as intervening variables.

To sum up, although vowels are dispensable, once introduced they seem to serve several purposes: (a) to disambiguate homophones and homographs; (b) to mark the pronunciation of other (typically adjacent) phonemes that may be pronounced in different ways; (c) to facilitate the parsing of sublexical elements; and (d) to signify phonological information.

The disambiguation of homographs is most prominent in the comparison between vowelized and unvowelized Hebrew words. Obviously, the number of

homographs in unvoiced words is much larger than in voiced words. Such disambiguation is more prevalent in English, for example, SEE–SEA, BLUE–BLEW. It takes advantage of the availability of alternative vocalizations in writing, usually referred to as the irregularity of grapheme-to-phoneme correspondence.

As markers for the pronunciation of other phonemes (other than that that the vowel itself represents), vowels mark vowel quality in English, such as the E in HOPE, or soft versus hard pronunciation of the consonants C and G. Historically, this was one of their roles in Hebrew, too.

Vowels functioning as markers of sublexical elements are deemed crucial in models of word parsing for the identification of syllable boundaries or for parsing subsyllabic elements such as “onset,” “rimes,” and “bodies.” However, whether word recognition relies on sublexical parsing is not at all clear.

Of course, vocalization specifies more completely (than the consonants alone) the manner in which words are to be pronounced. Still, the question remains as to whether, and under what circumstances, this information is actually utilized.

The body of this chapter so far has focused on studies that could shed light on this question by examining the potential role of vowels in Hebrew. In this linguistic context, most readers are equally familiar with voiced and unvoiced writing—a circumstance that seems to provide optimal control. Generally, these studies have shown that vowels may facilitate the reading of single words when presented out of context, particularly if the task requires pronunciation. Under conditions of single word recognition, vowel processing is apparently automatic. As a result, phonemic interference, when induced by incorrect vocalization, is practically unavoidable. But the effect of vocalization (correct or incorrect) is markedly different when words are read in context. Contextual cues can dramatically reduce, perhaps nullify, the benefits, otherwise evident, of vowel signs. Finally, it appears that although vowels may serve to disambiguate homographs, this function may in some cases exact a cost in processing time.

General Implications

What can be learned about the role of vowels in general, as signifiers of phonological information, from a comparison of reading English and Hebrew, or from reading voiced and unvoiced words? As has been shown already, vowels appear to be dispensable in both languages, although perhaps to a different extent. This is clearly the case in Hebrew, but English words too can be read more or less intelligibly without vowels. With some practice, English readers might arise who are expert in reading unvoiced English. Compared with today’s English readers, they would suffer less from the inconsistent grapheme-to-phoneme correspondence such as HAVE–PAVE, but would have to cope with a much larger number of homographs. The interesting

question is what would be the difference—in terms of reading processes—between reading the vowelized and the unvowelized words?

Unvowelized text would seemingly be read in English much as it apparently is in Hebrew, with maximal use of context. In terms of “interactive reading” (Rumelhart, 1977; Lesgold & Perfetti, 1981), reading unvowelized text may involve a relatively high degree of top-down processing (but see below for some reservations). As for vowelized text, the relative reliance on top-down versus bottom-up processing should probably depend on how systematically the vowel signs play their role throughout the writing conventions of that language. In this respect English and Hebrew differ remarkably. The vowels in Hebrew supply phonological information fairly systematically. Thus, compared with English, vowelization in Hebrew should allow more bottom-up processing, despite some remaining (relatively minor) irregularity of grapheme-to-phoneme correspondence.

A similar conclusion may be reached with the “dual routes” theory of lexical access (see above). Whereas the insertion of vowels should encourage the use of the indirect, “assembled phonology” route, a nonlexical route, at which decoding is achieved via grapheme-to-phoneme translation, reading unvowelized words is likely to rely more on the direct, visual, “addressed” route that relies on a search for the whole word in the mental lexicon.

Other linguistic and context-specific factors may influence the relative utility of the two routes. Irregularity (or inconsistency) of grapheme-to-phoneme correspondence, like in English, is likely to tilt the preference of access strategies toward the direct route, either as a first-choice routine or as a secondary (backup) mechanism. The indirect/phonological route may be more useful for processing unfamiliar, low-frequency, or particularly long words, which may then benefit more from the presence of vowels. Because much of the irregularity of grapheme-to-phoneme correspondence in English is carried by the vowels, this should encourage more reliance on the direct, visual (lexical) route, even when vowels are available.

Similar arguments regarding the differential processing encouraged by differences in grapheme-to-phoneme regularities between languages, namely deep versus shallow orthographies, have been put forward by other researchers as well (Feldman & Turvey, 1983; Katz & Feldman, 1983; Lukatela, Popadic, Ognjenovic, & Turvey, 1980; Lukatela, Savic, Gligorijevic, Ognjenovic, & Turvey, 1978; Turvey, Feldman, & Lukatela, 1984; Frost, Katz, & Bentin, 1987. See also Morton & Sasanuma, 1984; Besner & Hilderbrandt, 1987; Erickson, Mattingly, & Turvey, 1977; Tzeng, Hung, & Wang, 1977. For an extended discussion of reading in other alphabets, see Henderson, 1982, 1984; Rayner & Pollatsek, 1989).

As noted elsewhere, a more recent approach to understanding the processes underlying reading sets the notion of dual routes in a broader interactive framework. This new *connectionist* approach assumes that word recogni-

tion is accomplished through an accumulation of bits of information derived from several sources in parallel (see a detailed discussion in Seidenberg & McClelland, 1989; Van Orden et al., 1990; Taft, 1991). No source of information, in and of itself, need provide wholly adequate and unequivocal data for the execution of word recognition. Instead, data are accumulated from different sources until a certain threshold of activation is reached.

This approach may help to clarify the role of phonological processing in reading, including the role of vowels, because it maintains that phonological processing is supplementary or additive. Therefore, decoding an unvoveled word does not necessarily exclude phonological processing. Even if the unvoveled word is a homograph, and its reading is uncertain, the consonant letters may contribute important phonological information to the word recognition process by constraining the number of possible readings. Indeed, Lukatela, Turvey, Feldman, Carello, and Katz (1989) found that a string of consonants is an effective prime in disambiguating bialphabetic words in Serbo-Croatian. It may well be that just as whispers are perceived auditorily, despite their unstressed vowel phonemes, unvoveled (printed) words are recognized partly on the basis of phonological information, which, though incomplete, is useful for the word recognition process. At the same time, the new interactive approach assumes that the decoding of voveled and unvoveled words alike benefits from lexical and semantic input.

A number of empirical findings related to the issues discussed in this chapter support the new approach to reading, for example, Koriat's finding mentioned previously that the effect of context in lexical access is additive to other factors such as phonological and visual information. That is, the effect of vowelization is not completely eliminated by context. Similarly, Lukatela et al. (1989) found that context contributes to the disambiguation of phonologically ambiguous words. Also, Frost et al. (1990; see also Frost & Katz, 1989), together with others at the Haskins Laboratories, were at first convinced that in contrast to word recognition in English, word recognition in Serbo-Croatian is performed exclusively via the indirect, nonlexical (analytic) route of grapheme-to-phoneme translation (cf. Turvey et al., 1984). Yet in subsequent studies they reported that their Serbo-Croatian readers were also affected by lexical factors, so that "both lexical (and phonological) interpretations are automatically activated" (Frost et al., 1990, p. 576).

The new approach is also useful in explaining why, although in many cases vowels are redundant, such redundancy may be beneficial, due to the additive nature of the word recognition process. In general, an advantage of interactive models is that they can better explain the positive role of redundancies (cf. Seidenberg, 1990).

To further illustrate the merit of the new approach for understanding the role of vowels in reading, let us consider the broad outline of a possible connectionist model for reading Hebrew. The Hebrew reader seems to pos-

sess a number of interconnected sets of orthographic detectors, defined by some researchers as “access units” (Burani & Laudanna, 1992; Chialant & Caramazza, 1995) that are activated at the time of word recognition: (a) vowelized and unvowelized whole words, (b) word roots, (c) word patterns, (d) stems, (e) affixes, (f) letters, and (g) vowel signs. These are activated by particular orthographic structures and they transform orthographic input into phonemic and meaning elements (or features). In activating the phonemic elements, the system efficiently associates graphemes and phonemes, as required by the input, while assembling phonemic output in actual pronunciation or for assembling internal phonological structures, which may be useful in comprehension processes.

In the reading of Hebrew words, recognition of roots and affixes may be facilitated by the strong associative links (connections) between letters in roots, patterns, and affixes, respectively—a consequence of their appearing together, as invariants, in many words. In Seidenberg’s sense (1987), roots and affixes are strong letter coalitions. The visual separability of roots from affixes may partly explain why the reading of unvowelized Hebrew is so feasible.

Although unvowelized Hebrew may thus be particularly feasible, owing to the particularities of Hebrew morphology and to the graphemic separation of vowels and consonants, the same principles should be applicable, at least in part, to other languages as well.

Finally, although in general reading vowelized words may involve more extensive processing, this is not necessarily more time-consuming, as pointed out earlier. Because the activation of different sets of orthographic detectors may be performed in parallel, and because of the interactive nature of the word recognition process, there will often be an advantage to a multisource input.

In a parallel system with temporal noise and feedback, every redundant contribution is potentially helpful. In fact, word recognition seems to be overdetermined; namely, any one of several types of available inputs may be sufficient. Thus, under optimal reading conditions the contribution of one particular source of information may not be evident. Yet in less than optimal conditions, when word recognition is underdetermined (e.g., in some laboratory tasks), the contribution of a particular input may become both important and demonstrable.

An interactive model of reading that assumes parallel processing of multisource input can therefore apparently provide a satisfactory explanation for the role of vowels in reading. In the reading of unvowelized words, roots, patterns, and affixes may become more salient and important, their identification facilitating the word recognition process. In the reading of vowelized words the vowels contribute phonological information, which, although largely redundant, is generally useful (e.g., particularly under “noisy” conditions or when reading aloud). Under optimal conditions (e.g., with context),

the reading time of the two kinds of writing may not differ significantly. In some cases, however (depending on the particular language), vowels may actually be crucial for the disambiguation of homophones and homographs.

In summary, every analysis of the operation of writing systems must consider the individual characteristics of the language in question. Unvoweled writing may be optional or nonexistent in many alphabets. Its viability in Hebrew is probably enhanced by orthographic and morphological factors, which increase the salience of morphemic invariants such as roots, patterns, stems, and affixes. This does not mean that no lesson can be learned from one language about others. It does mean that such lessons are restricted. However, when language-specific restrictions are acknowledged, the justified generalizations gain validity.

With regard to the generalizability of the Hebrew findings discussed in this chapter, it seems useful to distinguish the “role of vowels” from the “contribution of vowels.” Roles are generally defined, and are potential. A role may or may not be filled under special conditions. Contributions are task-dependent and may be measured in reaction time or error rate. Thus, vowels retain their roles even when they do not, in fact, contribute to a specific word recognition task. For example, when context is relatively effective, the contribution of vowels may well be insignificant. But this does not mean that the vowels lose their roles. In less than optimal conditions (e.g., in tasks of single word recognition without contextual priming), or when reading aloud (e.g., in naming experiments), the roles of vowels—and their contributions—become apparent.

The nature of the roles played by vowels in reading appears to be common to all alphabetic writings, although the relative contribution of vowels to the reading process may differ in degree, from one language to another and in different reading tasks within the same language. Hence, the findings obtained with Hebrew texts should prove illuminating for understanding the basic principles of reading processes in other languages as well.

One or Two Strategies for Reading Voweled and Unvoweled Hebrew

Finally, it may be asked whether the reading of voweled and unvoweled Hebrew involves the same psychological mechanism and procedures or employs different strategies—as if, perhaps, executed by different reading registers. The issue was raised by researchers interested in the effect of orthographic differences on reading processes. It seems intuitively true that major orthographic differences such as those between logographies, syllabaries, and alphabets involve different decoding procedures (surprisingly, recent studies stress rather strong similarities—a matter on which I do not elaborate here; but see Perfetti, Zhang, & Berent, 1992).

The Orthographic Depth Hypothesis

But what about orthographic differences within the category of alphabetic writing systems? As we know, alphabets differ considerably in their representation of the spoken language. Some alphabets correspond to the spoken language simply, approaching a one-to-one correspondence between graphemes and phonemes, whereas in others the relationship is more complex. This matter has been explored by linguists (e.g., Chomsky & Halle, 1968; Weir & Venezky, 1973; Klima, 1972), as well as psycholinguists (particularly in the books edited by Kavanagh & Venezky, 1980, and in Henderson, 1984).

The basic premise of this effort was well defined by Liberman, Liberman, Mattingly, and Shankweiler (1980): "A reader is able to recognize a written word because he can equate it with some representation of that word stored in long-term memory" (p. 138). If "some" is underlined, the implications of this statement are that (a) such representation may be partial, and quite likely selective; and therefore (b) the graphemic representation of spoken languages is likely to be constructed on different principles.

The representation of English words in print is affected by both phonology and morphology (morphophonologically). The English word is conveyed as a sequence of systematic phonemes, divided into its constituent morphemes (cf. Chomsky, 1970). When phonology and morphology are in conflict, morphology often wins. For example, in HEAL, HEALTH, and HEALTHFUL the base morpheme "heal" is unchanged in spite of the phonetic variability. Thus the same morpheme can have various phonetic representations, depending on the phonological context (Chomsky & Halle, 1968). As a result, in reading English words one applies one's "deep" knowledge of the language.

In other languages phonemic considerations are more dominant as basic principles for the construction of the writing system. Such is the case, for example, in Turkish (Liberman et al., 1980) and Serbo-Croatian (Lukatela & Turvey, 1980). In these languages knowledge of grapheme-to-phoneme correspondences, although these are far from representing each and every aspect of the spoken language, affords sufficient clues for proper reading. Also, when word stems appear in different words or contexts (e.g., HEAL, HEALTH) the stems are written invariantly, that is, word context does not alter their writing.

The distinction discussed so far is related to what is known as the Orthographic Depth Hypothesis (ODH, e.g., Liberman et al., 1980; Katz & Frost, 1992). The so-called "depth" is related to the writing's remoteness from a simple phonemic representation. An orthography in which the letters correspond to phonemes in the spoken language in a more or less orderly fashion is defined as a shallow orthography. An orthography in which the grapheme-phoneme relation is equivocal or unspecified is defined as a deep orthography. As indicated earlier, a writing system can be classified as shallow for

only one reason, namely, a relatively simple grapheme-to-phoneme correspondence. But there can be infinite reasons why a writing system is a deep orthography; a complex representation of the spoken language in writing can assume all kinds of forms.

We saw earlier why English is qualified to be titled a deep orthography. Such a classification of unvoveled Hebrew (Bentin & Frost, 1987; Katz & Frost, 1992; Frost, 1994, 1998) is justified on different grounds. First, the lack of vowels in itself makes reading less dependent on simple grapheme-to-phoneme correspondence and more on knowledge of other aspects of the lexicon. For example, although the Hebrew word *barzel* 'iron' has just one pronunciation and one meaning when written without the vowels, the reader must consult lexical knowledge in order to pronounce it correctly. Translating graphemes (just consonants in the case of unvoveled words) into phonemes by itself will not do. The word recognition process becomes even more complicated when unvoveled words are homographs—having more than one entry in the lexicon. In reading these words, even consulting the lexicon will not suffice. One has to consider the context in order to grasp the right word.

In addition, in reading verbs and nouns that are composed of roots and patterns or stems and affixes, vowelization of the root consonants varies with the verb's inflection or the word's pattern. The pronunciation of these words is necessarily dependent on morphological knowledge, at times, completely idiosyncratic. However, comprehension of unvoveled Hebrew words may be due to the fact that keeping the root letters invariant, hence unvoveled, in all the words in which it is a central element may facilitate word recognition by providing a main clue to its identification, while at the same time leaving it ambiguous in regard to its phonological realization. This is, we may say, the blessing of ambiguity. The Hebrew root thus seems to play a similar role to some English stems (e.g., "HEAL" in HEALTH, UNHEALTHY, HEALING, and HEALTHFUL).

Voweled Hebrew, where diacritical marks and the vowel letters completely and consistently resolve all phonemic ambiguities, may be considered a perfect shallow orthography. Therefore, owing to their expertise in reading both voweled and unvoveled words, Hebrew readers can be tested for verification of the hypothesis of different processing in reading deep and shallow orthographies.

Katz and Frost (1992) and Frost (1994) examined this issue. They specified a strong and a weak version of the orthographic depth hypothesis (ODH). According to the strong version, shallow orthographies, they say, are "more easily able to support a word recognition process that involves the language's phonology. In contrast, deep orthographies encourage a reader to process printed words by referring to their morphology via the printed word's visual-orthographic structure" (Katz & Frost, 1992, p. 71). One implication

of the ODH, Katz and Frost suggested, is that the previously mentioned “assembled phonology” (i.e., grapheme-to-phoneme translation) is more prevalent in reading shallow than deep orthographies, and that this process of assembled phonology is conducted prelexically (i.e., prior to the recognition of the word’s meaning).

The theory further assumes that what characterizes lexical access in reading deep orthographies is processing of supraletter segments of the whole word in order to reach word identification in long-term memory. Such a process is triggered by the visual image of the whole word (rather than the grapheme-to-phoneme translation). If articulation is required, it will be done postlexically—phonological information required for articulation will be derived from knowledge of the word sound as stored in memory rather than from grapheme-to-phoneme translation.

Katz and Frost (1992), as well as Frost (1998) expressed reservations as to a strong interpretation of the ODH, which implies that the assembled phonology practiced in reading a shallow orthography can satisfy all that is needed for successful reading. They submit that assembled phonology in itself is insufficient for correct reading because it does not provide information about stress. There are in fact more parameters of articulation about which assembled phonology is mute, for example, tonality and spirantization as well as phrasal and sentential intonation. Consonants may change their phonetic values as a function of word context. For example, in articulating the letter T, the phoneme /t/ is sometimes transformed into /d/ in some phonemic neighborhoods. Therefore, no matter how shallow the orthography, the articulation of its written words can never rely exclusively on prelexical assembled phonology. Every grapheme-to-phoneme translation must be complemented by some form of top-down processing, which extracts information from knowledge of the word as a whole.

At the same time, we should add, the notion that in reading a deep orthography words are exclusively accessed by visual recognition of the word as a whole is no longer tenable. Besides being trivial, such a view is to some extent also flatly wrong. It is trivial because every reading must begin with visual processing of the print. It is wrong because recent studies with deep orthographies such as English and Chinese demonstrate quite convincingly that every lexical access involves immediate phonological processing after visual recognition of the letters has taken place. Considering these recent data (Berent & Perfetti, 1995; Booth, Perfetti, & MacWhinney, 1999; Lee, Rayner, & Pollatsek, 2001; Lukatela & Turvey, 1994a, 1994b; Van Orden, 1987; Zhang & Perfetti, 1993), it seems undeniable that at least some phonological processing in every kind of orthography is carried out prelexically, and that this phonological processing is involuntary and automatic. Therefore, every reading must contain both visual recognition (which may lead to postlexical addressed phonology) and assembled (prelexical) phonological

processing. What remains to determine is the relative involvement of these processes.

Frost (1994) set out a test for the ODH in Hebrew by examining readers' behavior in some laboratory tasks: (a) naming—a timed measure of single word articulation; (b) lexical decision—a timed decision as to whether a string of letters is a known word or not; and (c) semantic priming—a word recognition task where prior to being presented with the target word, the subjects are shown a semantically related prime.

As the theory goes, in a shallow orthography (in Hebrew, vowelized words), semantic priming should have greater effect in lexical decision than in naming because lexical decision requires a search in the mental lexicon but naming does not. In reading a deep orthography (in Hebrew, unvowelized words), fewer differences are expected between the two tasks because in this kind of orthography, even naming requires lexical search.

Participants' performance in these tasks was recorded as word stimuli were manipulated in terms of their frequency and their being recognizable words—as opposed to random strings of letters—nonwords. In the following, I pay more attention to the frequency effect and no attention to the words' status as a real or nonexistent word.

It is generally true that frequent words are recognized faster than infrequent words. In fact, some researchers argue that frequent words may be processed so fast, so that their recognition by direct association between the visual image and the word entry in the mental lexicon can be accomplished before any phonological processing even in a shallow orthography. According to this approach, the deep–shallow distinction should have an effect only with infrequent words (Baluch & Besner, 1991; Seidenberg, 1985; Seidenberg & Vidanovic, 1985; Tabossi & Laghi, 1992).

Frost's first prediction was examined in a naming task that requires word articulation, but not necessarily word identification in the mental lexicon. In this task, in reading a shallow orthography, where assembled phonology is the prevalent strategy, because exact word identification is not required for naming, shallow orthography words that are recognized through prelexical assembled phonology should be less affected by words' frequency.

Frost's second prediction is that in a task that combines naming with priming, words' frequency should be particularly noticeable in reading a deep orthography, but less so in reading a shallow orthography because in reading aloud deep orthography, the task starts with direct association of the word's visual image with its entry in the mental lexicon, and the phonology is postlexically recovered. Thus, because reaching a frequent word in the mental lexicon is faster than reaching an infrequent word, words' frequency should affect the initial step of reading in this task. The reading of shallow orthography should be less affected because it relies rather on prelexical phonology, which does not necessarily go through the mental lexicon.

In his first experiment, Frost (1994) found that in the lexical decision task there was not much difference in recognition time between the vowelized and the unvowelized words in both low- and high-frequency word groups. In the naming task, the differences between recognition time of vowelized and unvowelized words were much more pronounced. These results are consistent with the earlier studies of Shimron and Navon (1982) and of Koriat (1984, 1985). They are also consistent with a theory that sees the lexical decision task as involved in addressed phonology—one that requires a search in the mental lexicon. According to this view, word frequency is expected to affect search latencies, as was indeed found in both vowelized and unvowelized words. The naming task involves assembled phonology (grapheme-to-phoneme translation). So a search in the mental lexicon is unnecessary for naming, and a frequency effect is less expected as was indeed the case.

Frost interpreted his findings to suggest that “the presentation of vowel marks encouraged the readers to adopt a strategy of assembling the printed word phonology by using prelexical conversion rules” (1994, p. 121).

In his second experiment, Frost (1994) examined the facilitation afforded by semantic priming in the naming task. As noted, the orthographic depth hypothesis assumes different strategies for reading deep and shallow orthographies. It expects semantic priming in the naming task to be more effective in deep orthographies (in Hebrew, unvowelized words), where reading relies on lexical search in the mental lexicon, and less effective in shallow orthographies (Hebrew, vowelized words), where reading relies mostly on prelexical assembled phonology. Frost and his colleagues (1987) and Katz and Feldman (1983), in fact, showed that semantic priming is not effective in a shallow orthography such as Serbo-Croatian. Indeed, there was a larger effect of semantic priming in the unvoweled print. These results are again consistent with the findings of Navon and Shimron (1985) and of Koriat (1984).

In his third experiment, Frost (1994) compared reading vowelized and unvoweled words in naming and lexical decision tasks in a way that assessed the contribution of vowel signs under artificial conditions where the vowels appeared immediately following the consonant letters or after a delay of 100, 200, or 300 ms. Frost expected with that experimental design to assess the cost of denying vowel information. The words used as stimuli in this (and in the previous) experiment were only Hebrew words that even when unvoweled are not homographs (i.e., having just one possible reading in the unvoweled print).

Frost hypothesized that through this task he might determine how long subjects are inclined to delay their response and wait for the vowel signs. “Inclined” in this context is certainly not a matter of consciousness, which cannot be operationalized in such short periods. Frost found that vowel delay was largely ineffective in the lexical decision task. Its effect was greater with naming, but even there it was quite small with high-frequency words, until

the 300 ms delay. The effect of the delay was more evident with low-frequency words, and more still with nonwords.

Frost interpreted the results as pointing to a lexical search (addressed), rather than an assembled-phonology strategy of recoding in the lexical decision task. Thus he implied that subjects made their decision based on familiarity with the unvoveled word image. However, unlike naming, which requires proper pronunciation, in performing a lexical decision task, minimal evidence of the word's identity is sufficient. So even if lexical decision is aided by phonological information that is available even in the unvoveled words, it can be easily advanced without complete phonological processing.

In the naming task, the vowel delay was more effective, particularly with the longer lags. According to Frost, this indicated that in this task subjects were more inclined to wait for complete vowel specification, "presumably in order to generate a prelexical phonological code" (1994, p. 124). However, immediate phonological information may well have facilitated naming as a word-pronunciation task, whereas delayed phonological information brought the task closer to naming unvoveled words, a slower processing in the majority of the studies described in this chapter.

In summary, what is the contribution of the ODH theory to our understanding of reading Hebrew? Does it support advocating different strategies for reading voveled and unvoveled words? Several points should be mentioned. First, there is one facet of the ODH that was not directly examined by researchers of Hebrew, although the data gathered in other studies is indicative. The essential feature of the ODH is that unlike a shallow orthography, which is fairly transparent (regular) in representing spoken words, a deep orthography is opaque or ambiguous. In Hebrew, the unvoveled print was viewed as always ambiguous as regards pronunciation, and sometimes also semantically ambiguous—when unvoveled words are true homographs—having more than one vowelization, hence more than one meaning. Indeed, the authors of several studies conducted at the Haskins Laboratories (e.g., Feldman & Turvey, 1983; Lukatela, Feldman, Turvey, Carello, & Katz, 1989; Lukatela et al., 1980) asserted that phonologically ambiguous words for Serbo-Croatian readers are read more slowly than phonologically unambiguous words.

This was not what Bentin and Frost (1987) found with regard to Hebrew. In their study they examined the reading of voveled and unvoveled Hebrew words that, although homographs, have the same unvoveled print. In both the lexical decision and the naming tasks, as pointed out earlier in this chapter, the time of reading the low frequency unvoveled (ambiguous) homographs was shorter than the time of reading their voveled (unambiguous) counterparts.

However, the results of Frost (1994) previously discussed are fairly consistent with those emerged from previous studies. This refers specifically to the effect of word frequency on lexical access and naming of voveled and

unvoweled words, the different effects of phonological processing in naming and lexical access of Hebrew words, and the effect of semantic priming on lexical decision and naming of Hebrew words (Koriat, 1984, 1985; Shimron & Navon, 1982, 1985; for review, see Shimron, 1993).

The weak version of the ODH (Katz & Frost, 1992; Frost, 1994, 1998) admits a great deal of relativity in the ODH distinction between deep and shallow orthographies. It acknowledges that some lexical information is necessary for correct reading in every orthography. It is less clear about the amount of phonological information in reading deep—in fact every—orthography. But the evidence of such a role is undeniable (Berent & Perfetti, 1995; Frost, 1998; Lukatela & Turvey, 1994a, 1994b; Van Orden, 1987; Zhang & Perfetti, 1993). Therefore, it seems quite clear that more than one recoding strategy is simultaneously at work in word recognition. The question is what is the relative strength of the processing based on assembled phonology as opposed to lexical information? The answer seems to depend on several factors: word frequency, availability of semantic-contextual information, and yes, the simplicity or the fluency of deriving phonological information from the print.

If in Hebrew, word recognition is examined with words that remain unambiguous even when unvoweled, the only difference between the vowelized and the unvoweled words lies in the amount of phonological information provided in the print. There is no question of ambiguity or equivocality in pronouncing most of these unvoweled words. Hebrew readers are well familiar with both the vowelized and the unvoweled versions, and this familiarity dictates only one possible articulation in the two types, just as it evokes the same unambiguous meaning of the word. As regards Hebrew, instead of the depth metaphor that alludes to levels of linguistic knowledge, and may better suit English and other languages, it would be simpler, more concrete, and more precise to speak of the amount of phonological information given.

As pointed out previously, even in reading the vowelized words the reader must consult the mental lexicon, if only to determine the word's stress. Thus on the one hand, no naming can afford to circumvent the mental lexicon. On the other hand, the reader's dependence on phonological processing appears obligatory and automatic, and it is probably operational to some extent even in lexical decision.

The strong ODH emphasizes different strategies for reading deep and shallow orthographies (and neglects the issue of their interaction or their parallel processing). Such a version would imply different strategies for reading vowelized and unvoweled Hebrew. The evidence from Hebrew, I think, favors a weak version of the ODH, which allows both strategies to work simultaneously. The alternative approach may also stress the task conditions and requirements and their effect on the relative strength of the parallel processes. Accordingly, the differences between lexical decisions and naming in

reading vowelized (shallow) and unvowelized (deep) Hebrew may be explained as follows. Lexical decisions do not require articulation or semantic processing. Under laboratory conditions, where subjects are required to act as fast as possible, it may be accomplished with partial evidence of the words' identity. As a result, lexical decisions are less affected by the provision of vowel signs. Apparently, consonant letters, processed visually, and possibly also phonologically, are sufficient for the job.

Naming, by contrast, requires articulation, albeit not semantic identification. Therefore, it takes advantage of vowel signs (when provided), but is less affected by semantic priming, which is not required. But again, naming also involves the mental lexicon.

In summary, contrary to the strong version of the ODH, I propose that subjects do not seek a single fitting strategy for the reading task. All strategies are always simultaneously at work, and it is the available data in the print, and the task requirements, that dictates the nature of the reading processes.

4

Morphological Aspects of Reading Hebrew Words

This chapter is about the psychological aspects of reading Hebrew words, with a focus on word morphology. Most Hebrew words are complex, in the sense of being composed of sublexical elements (morphemes). We noted in earlier chapters that all verbs and most nouns have roots, generally consisting of three consonants, which are embedded in a pattern. The pattern consists of the vowels by which the root consonants are articulated and potentially flanked by initial and/or terminal phonemes, which may or may not be considered affixes. Linear affixation also plays a role in both inflections and derivations. Affixes are attached to the word's base, a free morpheme, and a word in its own right (e.g., *perax* 'flower', *erec* 'country'), or to the word's stem, which is the form of the base in inflected or derived words, e.g., *prax-im* 'flowers' *arac-ot* 'countries'. (Stem letters are marked with bold letters.) The stem as defined here often differs from the base, mostly in its vocal pattern as in the examples above.

Our interest in complex words is twofold: one concerns the linguistic operations involved in word comprehension, word production, inflections, and derivations; the other concerns the storage of words and subword (sublexical) elements in the mental lexicon. The organization of the mental lexicon and the linguistic operations are interrelated because linguistic operations, such as inflections and derivations, are executed by manipulation of the linguistic entities stored in the mental lexicon—composing, decomposing, and/or modifying them.

In modeling the mental lexicon, psycholinguists ask, for example, if it contains every word with all its inflections, regular and irregular alike, or perhaps only irregular inflections on the one hand, and sublexical elements such as roots, patterns, affixes, and stems on the other. With these sublexical ele-

ments one is able to produce regular inflections “online” according to linguistic rules (defaults). The latter possibility is undoubtedly more economical. But is it also more effective, and does it faithfully reflect the psychological evidence? The following sections deal with these and other questions.

Compositionality and Productivity

Languages differ in their degree of morphological complexity. In principle there could be a language with zero complexity—no derivations, inflections, or conjugations, and no combinations of morphemes or modifications of word structures. In such a language, tense, person, number, and gender, if applied, would be indicated by independent words, like “will,” marking the future tense in English, and unlike the suffix *-ed*, marking the English past tense. But the words of most languages do seem to have some morphological complexity (Dressler, 1981), and the extent of its psychological implications is now a subject of intensive psychological research (Assink & Sandra, 2003; Feldman, 1995; Frost & Grainger, 2000; Frost, Grainger, & Rastle, 2005; Hammond & Noonan, 1988; Marslen-Wilson, 1992; Marslen-Wilson, Tyler, Waksler, & Older, 1994; Shimron, 2003; Verhoeven, & Perfetti, 2003).

Since the early 1970s an abundance of evidence has accumulated suggesting that readers and speakers are sensitive to sublexical elements—the elements of which a complex word is constructed (for a review of the initial research, see Taft, 1991)—and that this sensitivity affects the psychological operations involved in recognizing words. The suggestion is that on encountering a complex word the reader or the speaker comprehends it by analysis and synthesis. The reader identifies the word stem (or base) and affixes, recognizes them for what they are, and then synthesizes the meanings of the whole word. Such a hypothesized activity is known as **word decomposition** (Taft & Forster, 1975, 1976).

Chomsky (1993, 1995) postulated for each language a mental lexicon and a computational system. The lexicon specifies the lexical items (words) with their idiosyncratic properties, such as phonological structure, categorical features, semantic and syntactic characteristics, and morphological structures. An extensive discussion of the mental lexicon is set forth in Pinker (1999).

Several models have been suggested to portray the structure and the content of the mental lexicon. They range from assuming storage of all words, including inflected words in every form (e.g., Butterworth, 1983; Bradley, 1980; Kempley & Morton, 1982), to storage of word stems, together with a list of morphemes that may be attached to the stems for inflection and derivation (e.g., Jarvella & Meijers, 1983; Taft & Forster, 1975; Taft, 1981). Intermediate models have also been suggested (e.g., Caramazza, Laudanna, & Romani, 1988; Stemberger & MacWhinney, 1986).

An entirely different approach to the mental lexicon is known as Connectionism or Parallel Distributed Processing, PDP. This approach is not committed to the notion of morphemes as defined by linguists, and instead concentrates on patterns of sounds or letters that frequently appear in our speech or reading. Frequent appearances make the patterns more accessible, and facilitate word recognition by matching the mental patterns with those in the stimulus. When a complete match is found, the recognition of the stimulus is made easier. I find this approach particularly fruitful in explaining the initial (perceptual) steps of word recognition. It may be less fruitful in explaining linguistic operations (e.g., inflections) in which manipulations of linguistic elements such as roots, patterns, bases, and affixes are assumed. The reader interested in PDP is referred to Rumelhart and McClelland (1986) and Seidenberg and McClelland (1989). Empirical evidence for and against this approach is provided by Plaut and Gonnerman (2000); Rueckl and Raveh (1999); and in Hebrew, Velan, Frost, Deutsch, and Plaut (2005).

The study of Hebrew and other Semitic languages is particularly interesting because most psycholinguistic studies have been conducted with speakers of languages of Indo-European origin, many of which are typologically closely related. Only in the last decade or so have we witnessed an increase in the number of studies on word decomposition in languages of other origin, with considerably different morphological features. Hebrew, among other Semitic languages, is interesting because of the nonlinear composition of its bound morphemes, the root and the pattern (see chapters 1 and 2). The advantage of focusing on Hebrew (among other Semitic languages) is twofold: (a) it illuminates psycholinguistic processes in languages that have scarcely been investigated, exemplifying morphological structures different from those in Indo-European languages; and (b) it provides evidence for evaluating the universality of general psycholinguistic models.

Inflected and derived words are produced in many languages by affixation of the base, the central word element to which affixes are attached. For example, *walk*—*walk-ed*, *walk*—*walk-er*. Affixes are considered morphemes that qualify word meaning and its syntactic role. It is generally accepted that inflections and derivations differ on a number of dimensions (e.g., Anderson, 1982; Henderson, 1985b). Inflections (e.g., *walked*) are highly productive: they are executed according to linguistic rules with minimal exceptions, do not change word class, e.g., *walk* $\Rightarrow$ *walked* (both words are verbs), and are typically considered versions of the same lexical item, where the selection of a particular version has to conform to the syntax of the sentence in which it appears. Because they are considered different versions of the same lexical items they may not be listed as separate items in the dictionary. Derivations (e.g., *walker*) are much less productive. They often change the word class, e.g., *teach* (verb) $\Rightarrow$ *teacher* (noun), and are typically listed in the dictionary as independent entries.

Time Dimension in Word Recognition

In the initial stages of word recognition, speakers and readers may be sensitive not only to morphemes, as the linguistic building blocks of complex (polymorphemic) words, but also to clusters of letters or sounds known as bound morphemes. These are morphemes that cannot appear as independent words and do not necessarily have a meaning, e.g., *-ceive*, as in *conceive*, *perceive*, and *deceive*; or *-gress* as in *congress*, *progress*, and *ingress*. Speakers and readers may be also sensitive to pseudo-morphemes, e.g., the unit *re-* when it is not a prefix, as in *relish*, or the unit *-er* when it is not a suffix, as in *cover*. In addition, psycholinguists also investigate sensitivity to forms that are neither morphemes nor pseudo-morphemes, but simply clusters of sounds or letters that appear in a number of words. Examples are *broth* in *brothel*, *brother*, *brotherhood*, and *broth* (cf. Rastle & Davis, 2003; Rastle, Davis, Marslen-Wilson, & Tyler, 2000).

Research on word recognition found that these orthographic or auditory clusters may function as mediating devices, sometimes referred to as **access units**. Because the reader is familiar with these, they are easily recognized and then facilitate recognition of larger units such as stems, bases, and words (cf. Chialant & Caramazza, 1995; Schreuder & Baayen, 1995; Baayen & Schreuder, 1999). Indeed, sensitivity to purely structural sublexical elements in the initial stage of word recognition was found in a variety of Semitic and non-Semitic languages (Boudelaa & Marslen-Wilson, 2001; Frost, Deutsch, & Forster, 2000a; Frost, Deutsch, Gilboa, Tannenbaum, & Marslen-Wilson, 2000b; see McQueen & Cutler, 1998 for a review).

In Semitic languages the root and the pattern, as we shall see shortly, are apparently familiar sublexical elements. However, in the initial stage of word recognition (say, within the first 50 ms) the root and the pattern may not yet be associated with the root's meaning or the pattern's phonological values and syntactic indications. Such information is perhaps retrieved later, on the way toward complete word comprehension, which takes several times longer than the initial recognition of orthographic units.

Thus the roots and the patterns may carry different attributes (features) along the time course of word recognition; serving as mediating sublexical elements at the initial stage, that is, when they are deprived of much of their semantic and syntactic meaning; but they become meaningful and all-purpose morphemes some time later (cf. Frost, Kugler, Deutsch, & Forster, in press). I will have more to say about the time dimension of word recognition in discussing the experimental evidence below.

My suggestion here is consistent with a number of word recognition models, which describe word recognition as a multiphase process. One of these proposes the construct of access units, described above. As defined by Chialant and Caramazza (1995) in their description of the Augmented Addressed

Morphology model (AAM), this model presents the mental lexicon as a memory store that contains whole words, including inflected and derived words, but also sublexical elements. As noted, in the context of visual word recognition (reading), access units, as orthographic clusters, function at the initial stage of word recognition as mediating devices (gates) and facilitate immediate recognition of larger units.

Another model of word recognition that takes into account the time dimension is the Meta Model for Morphological Processing suggested by Schreuder and Baayen (1995). It assumes three stages of word recognition. The first, **segmentation**, involves mapping the input onto access representations; the second, **licensing**, involves checking whether the activated access representations can be integrated according to their properties; and the third, **combination**, integrates the licensed units.

In addition, the Entry Opening Model suggested by Forster (1999) postulates two stages of word recognition. The first is affected by frequency and is very fast—so fast that it cannot determine whether the mental lexicon entry exactly matches the input (close matches are also processed). The second is a verification stage: it evaluates whether the input is a suitable match with the mental lexicon entry.

A number of studies (e.g., Feldman & Soltano, 1999; Rastle et al., 2000) show sensitivity to opaque units when priming a word for no longer than 45 ms, a sensitivity that disappeared when the presentation of these primes lasted about 230–250 ms (cf. Longtin, Segui, & Hallé, 2003).

Finally, Rastle and Davis (2003), summarizing a series of studies on word recognition in English, submit that “[T]here is a level of presentation contracted in early visual word recognition that is structured on the basis of morphological units defined orthographically rather than semantically” (p. 296). The authors further suggest that the benefit of sensitivity even to orthographic forms that are neither morphemic nor even pseudo-morphemic entities lies in its preserving what they call “position invariance.” For example, it preserves the identity of the cluster *trust* in words such as: **trust**, **trusty**, **distrust**, **untrustworthy**. As shall be seen below, position invariance is also kept in Hebrew writing (voweled or not) with regard to the position of the root letters within Hebrew words.

Empirical Findings

The findings of linguists and psycholinguists evince an interesting division between linguists and psycholinguists. Several linguists have challenged the perception of root and pattern as the central morphemes of Semitic words. Some of them suggest that the Semitic base or stem should be considered the central unit of Semitic words (for an extensive discussion see Shimron,

2003). However, research on word acquisition in Hebrew as well as experimental laboratory studies indicate that roots and patterns probably exist in the mental lexicon of Hebrew speakers. A central goal of this chapter is to explain this conflict of views. Essentially, I maintain that once a base or a stem is formed, the root and the pattern may lose their active role and the stem or the base become the central linguistic entity in its own right. By this view, linguistic operations such as inflections and derivations may be said to engage bases and stems, rather than roots and patterns. However, if this is so, the Hebrew language, and perhaps other Semitic languages as well, loses much of its morphologically nonlinear characterization and should be construed as similar, say, to the Indo-European languages. As we shall soon see, this is the position taken by several experts on Semitic languages, but the issue is not settled yet.

*Reservations About the Centrality
of the Root and the Pattern Constructs:
The Linguists' Angle*

Hoberman and Aronoff (2003) pointed out that in a contemporary Semitic language, Maltese, "the productive verbal morphology is decidedly affixal" (p. 63). They seem to mean that sublexical elements of Maltese words are concatenated linearly. Therefore, they added, "Semitic is no different from any other language family: to the extent that members of a family share some peculiar trait, it is purely an accident of history . . ." (p. 63). For them, the alternative to the root and pattern construct is what they call "templatic morphology." That is, "affixes occur in a fixed order, sometimes unmotivated from a syntactic or a semantic point of view . . ." (p. 63). Thus verbal patterns consist of an "inner stem with fixed vocalism and a fixed prosody [i.e., pitch, loudness, tempo, and rhythm]; surrounded by fixed affixes (if they are present) and in some cases, different prosodies and vocalisms in different tenses, aspects or moods" (p. 63). Moreover, they suggested that this "is true of modern as well as classical Semitic languages and the patterns govern the shapes of borrowing quite rigidly even in languages like Modern Hebrew" (p. 63).

True enough borrowing in Hebrew has raised doubts among several linguists about the dominance of the root and pattern as a governing factor in Modern Hebrew word formation. Particularly relevant here is the process of incorporating a loan word and making it a legal word in the Hebrew lexicon, ready to be inflected or derived like all other words. According to Berman (1987a, 1987b), Ornan (1983a, 1983b, 1990a, 2003), and Schwarzwald (2000), the mechanism involves (a) extracting the consonants from the borrowed word, and (b) inserting the consonants (now considered root radicals) into an existing pattern. For example, after the consonants of the loan word *format* 'format' are extracted, the novel root, *F-R-M-T* can be

used in verbs, nouns, and other word groups, for example, *le-FaRMeT* 'to format'.

However, because borrowed words often have more than three consonants, as in the example just given, going by the traditional way of forming denominative verbs (i.e., verbs formed from nouns) of four-consonant roots, they should have, for example, the CVCCVC structure, like *misper* 'enumerated' from *mispar* 'number' or *firmet* 'formatted' from *format*. But this is not always the case; Bolozky (1978) pointed out a strong tendency in Modern Hebrew to preserve clusters of consonants as in the source word. Thus, a denominative such as *priqlet* 'advocated', derived from the noun *praqlit* 'advocate', does not adhere to the expected placement of roots inside the pattern, which should be **pirqlet* (* marks an illegal word). Similarly, the verb *hitpraqlit* 'became a lawyer', in the *hitpa'el binyan*, should conventionally be **hitparqlet*. Apparently, some denominatives are affected by factors related to their borrowed source rather than obeying the rules of Hebrew word formation.

Bat-El (1994) also suggested that "The [traditional] model of Semitic verb formation . . . cannot account for [the consonant] cluster transfer without some ad hoc lexical marking [specific word construction]" (p. 579). She added, "It is necessary to abandon [root] Extraction plus Root-to-Template [pattern] Association and to consider Stem Modification as the appropriate approach" (p. 581). On the root as the governing element of Hebrew word formation, Bat-El suggested that "what is crucial is the bisyllabic structure" (p. 592).

Rose (1998) likewise opposed the traditional root-based view in her analysis of the Ethiopian languages. She concluded that neither patterns and roots nor word-based models of derivation can capture the range of possibilities in this domain.

Benmamoun (1999, 2003) suggested, regarding Arabic that "the two fundamental assumptions, namely, the central role of the root in deriving words and the status of the template [pattern] as the realization of grammatical forms, are not empirically valid." Moreover, "lexical relations in Arabic are based on derivations involving words/lexemes and morphemes, very much like in English" (2003, p. 102). Benmamoun suggested viewing the Arabic imperfective as a default form of the verb when it does not carry temporal or aspectual features. The imperfective, he suggested, acts as an input to Arabic word formation processes and is used to derive other verbal and nominal elements. As the unmarked syntactic form, the imperfective is affixed to encode person and number features. Ussishkin (1999a, 1999b) made a similar suggestion for derivations in Hebrew.

McCarthy (1993) also proposed a mechanism that requires the vocalic and the consonantal properties of the base form as one unit to derive other lexical forms, as an alternative to the root and pattern model of word formation.

Along this line of arguments, Heath (1987) suggested that although a case might be made for consonantal roots in strong verbs in Moroccan Arabic, it will not hold for weak or hollow stems. As for nouns, Heath found no reasonable way to separate consonants and vowels into different levels because the vowels cannot be grammatically motivated. Like Benmamoun, he suggested that Arabic has a core of underived stems (bases), such as the singular of simple nouns and the imperfective of simple verbs. These underived stems can be fed into derivational processes that produce derived stems by ablaut (vowel alteration) or affixation, or both. The input to the derivation processes is often an underived stem, but may also be the output of an earlier ablaut derivation.

Note that neither Heath nor Benmamoun argued that Arabic is not productive. Rather, they both suggested that different patterns of productivity are applied to particular language domains. They nonetheless insisted that the idea of a generative master-plan made of a word that contains a stem composed of a root and a vocalic pattern does not work for very many linguistic domains. At times the stem or even the word as a whole is the input for further derivations.

Finally, in a recent paper Gafos (2003) discussed the construct of linguistic paradigms as regulating and restricting the diversity of Semitic stems as central elements within these paradigms. He argued that “grammar, as a system of lawful relations between words, must have access to more richly specified underlying representations than allowed by consonantal roots” (p. 348). Gafos offered a distinction between **grammar** and **processing**:

Phonology and morphology are components of the grammar. Lexical processing is the grammar in use. The relation between grammar and processing is complex or at least indirect (Chomsky, 1965). The information structures implicated in processing must be related to units of morphology, but that does not mean that they must be exactly identical to them. . . . [M]orphology may operate on units distinct from consonantal roots. (p. 348)

I return to this view in summarizing the differences between evidence brought by linguists and psycholinguists.

Psycholinguistic Evidence of Morphological Awareness in Language Acquisition

The root-based approach looks quite different when psycholinguistic data are considered. Two groups of psycholinguists suggested evidence regarding morphological knowledge in speakers of Semitic languages, one adduces evidence from language acquisition data and the other from experimental labo-

ratory data (generally with adults). Among the language acquisition researchers, Berman (e.g., 1987a, 1987b) collected her data from Hebrew-speaking children's lexical innovations. She argued that for speakers of Hebrew, the consonantal root has definite psychological reality as both the structural and the semantic basis for new-word formation. Moreover, this is true not only for more erudite literate members of the Hebrew-speaking community. It also applies to those naively 'natural' of speakers, preliterate, preschool children who do not have access to the orthographic representation of the words they know and who have not been explicitly introduced to the grammatical notion of root in the formal school study.

Berman collected her data by presenting children with existing words and asking them to make up words with the same roots, but in patterns that are not normally inflected or derived with these roots, although they could have been. In a sense, they were asked to coin words that fit those empty cells in the root-pattern matrix depicted earlier in chapter 2. As noted, new verbs can be derived from nouns, adjectives, or other verbs. Such derivation requires two kinds of operations: root extraction and pattern assignment. With root extraction, the speaker identifies the consonantal skeleton out of which a word is formed. With pattern assignment, the speaker assigns a suitable affixal pattern to this root so as to produce a verb that is structurally well formed and semantically appropriate. The critical question is whether these processes will give rise to a verb that is faithful to classical Hebrew verb formation even though currently and historically it is nonexistent.

Generally, the variability of responses recorded by Berman was found to be correlated with age; older children responded more predictably. In addition, the less canonic or transparent the source noun's consonantal base and syllabic structure, the poorer was the match between the base consonants of the source noun and those used in contrasting novel verbs. Yet from a young age children were able to identify and isolate the consonantal skeleton when coining such new verbs (success rate of about 80% among preschoolers and above 90% among school-age children). Berman found that children aged 3 or 4 were less successful in verb innovations; they gave far more varied, often idiosyncratic, responses to most items. The four- and five-year-olds, however, attained over 80% success. Yet even the three- and four-year olds produced very few items that violated Hebrew verb-structure constraints.

Berman (2003b) concluded, "Hebrew-speaking children can perform consonantal root extraction from as young as age three years both in interpreting and producing novel verbs in relation to familiar nouns and adjectives" (p. 274). Moreover, as soon as they are able to derive novel verbs, they do so in the classical Semitic way. More examples and references may be found in Ravid (1995, e.g., p. 33).

Evidence from Experimental Studies of Semitic Morphology

Experimental studies on Hebrew morphology are only a decade and a half old. They were apparently triggered by the growing interest in studies of word recognition, also referred to as “lexical access” and “word comprehension” (Balota, Flores D’Arcais, & Rayner, 1990; Taft, 1991; Feldman, 1995; Pinker, 1999). Early studies on the morphological base of word recognition, inspired by the pioneering work of Taft and Forster (1975, 1976), investigated European languages. Basically, they can be seen as an attempt by psycholinguists to examine issues of generativity and productivity in morphological processes, and the nature of our mental lexicon. One question, as we have seen, is whether the mental lexicon is organized by “full listing” or by a more economical and morphologically dependent storage. Full listing means that all words, simple and complex, derived, inflected or not, are listed in the mental lexicon as whole units, regardless of their internal structure. If this is how our mental lexicon is organized, the investigation of morphological processes such as inflections and derivations comes down to finding how lexical items are linked in our mental lexicon, and what influences the activation of the associations between the words. Any other model of the mental lexicon assumes that in ongoing linguistic activity the language speaker manipulates (composes and decomposes) sublexical elements (morphemes) according to some rules or default procedures. Some theories, as noted, suggest that except for irregular words, the lexicon stores separately the word stems and affixes. These parts combine or decompose according to our needs when we comprehend or articulate words.

The following review of experimental studies focuses first on the sensitivity of Israeli speakers to sublexical elements of Hebrew words in the process of word recognition and comprehension. The studies under review are mainly arranged according to the psychological issues concerned, but also with regard to the experimental methodologies designed for obtaining the evidence.

The psychological process of visual word recognition (reading) takes place in several steps. The initial step is, of course, visual identification of letters and words, but immediately after comes phonological and morphological decoding, together with a search for the entire word in the mental lexicon (Berent & Perfetti, 1995; Booth, Perfetti, & MacWhinney, 1999; Lee, Rayner, & Pollatsek, 2001).

Because the entire psychological process of word recognition is complex, no single experimental design can reflect it in its entirety. Some methods are more sensitive to the visual aspects of the word’s orthography, others to the word’s phonology, morphology, or semantics. In addition, some designs may be useful for obtaining information on the earlier steps of reading, when perceptual processes are active, but not on later steps, when higher processes of

semantic and comprehension processing are performed. Next, each method is introduced and its findings are given.

Repetition Priming. A precondition for word decomposition into sub-lexical elements is the language speaker's/reader's sensitivity to these elements. In Hebrew, research on such sensitivity was first conducted some 15 years ago by Bentin (1989), and subsequently by Bentin and Feldman (1990; Feldman & Bentin, 1994). The initial studies applied an experimental paradigm known as "repetition priming," an elaborated form of presenting the stimuli in word recognition tasks, in experimental settings such as lexical decision, naming, categorical decision, and more. In a lexical decision setting, the participants are asked to read a list of strings of letters (technically called stimuli) comprising words and nonwords, and their task is to decide, as fast as possible, whether these strings are existing words. The stimuli are of two kinds: a "prime" and a "target." The prime may be related to the target or not. A "related" prime is a stimulus that precedes the target, and its appearing before the target is assumed to affect the reading of the target in some systematic way, owing to the relationship between them. The related prime has something in common with the target word (e.g., sounds, letters, morphological attributes, or meaning, as defined by the experimental hypothesis). A "priming effect" is found when the prime makes the reading of the target significantly faster (or slower) than the reading of a target preceded by an unrelated prime. Maximum priming effect is obtained when the prime and the target are identical; in reading the same stimulus twice, the second reading is always faster.

Another measure indicating the effect of the prime in repetition priming experiments is the number of words in the list that appear in between the prime and the target. A prime may appear immediately before the target or several stimuli earlier. This manipulation may indicate the strength and duration of the sensitivity (arousal) caused by the prime.

The target is the stimulus seen last. Upon its presentation, the participant is asked to respond, and his or her response is recorded in terms of the length of time (latency) between the target's onset and the participant's response. The number of errors is also recorded. In a lexical decision task, the participants indicate their decision on whether the target is or is not a word by pressing a "Yes" or a "No" button. In another experimental paradigm, known as "naming", the participants are asked to read the target aloud. In this paradigm the time from the presentation of the target to the participant's articulation of the target is the measure of the priming effect.

In a lexical decision study by Bentin and Feldman (1990), taking advantage of the many kinds of words in which a Hebrew root may appear, the primes were Hebrew words related to the target word in one of three ways: a semantic link, a morphological link, or both. For example, when the target

was *sifriya* 'library', built with the root S-P-R (/p/ is replaced with /f/ in certain word contexts), which is associated with several meanings, among them books and numbers, the semantic prime was *kri'ah* 'reading' (no common root); the morphological prime was *mispar* 'number' (prime and target share the same root, but are not semantically related); and the semantic+morphological prime was *safran* 'librarian' (prime and target have the same root and are semantically related).

When the primes preceded the targets by a short interval (lag), immediately before the target, a priming effect was obtained in all three conditions, although the semantic and the semantic+morphological priming had a significantly greater effect than the morphological priming alone. However, with long-lag repetitions a priming effect was obtained only with the morphological and semantic+morphological priming. Because the morphological relationship was based on the repetition of the root, the results supported the assertion that Hebrew speakers recognize the root during the process of word recognition. That is, a common root was found to furnish effective primes and seemed to function as an access unit that modulates the reading of the target word.

Goral and Obler (2003) continued along the experimental path of Taft and Forster (cf. Taft, 1991). In a simple lexical decision task (without manipulating the primes' lag) dealing with verbs only, they compared the recognition latency of words and of two types of nonwords. One type was strings of consonants set in normal Hebrew word patterns but their roots did not exist in Hebrew. The other type of nonwords had real roots inserted into existing patterns, but not those generally used with such roots (recall the empty cells in the root-pattern matrix discussed in chapter 2). The participants' task was to decide as soon as possible if the stimuli presented to them were existing words or not. Their decision was marked by pressing a "Yes" or a "No" button. The time from the onset of the stimulus to the participant's decision, and the errors they made, were recorded.

The authors reasoned that if the nonwords composed of real roots were decomposed, and the real roots were recognized as familiar roots, they would slow down the No response in the lexical decision task. But if decomposition did not occur, all nonwords should be rejected equally fast. Overall, it indeed took longer to reject nonwords consisting of a legitimate root. The error rates were higher and the response times were longer in the real root nonword condition. Thus, this study converges with repetition priming studies in supporting the assertion that Hebrew roots are recognized as linguistic entities in the process of word recognition.

In another experimental paradigm, known as "segment shifting," Feldman, Frost, and Pnini (1995) asked Hebrew speakers to take a segment of a "source" word and attach it to a target, thus forming a morphologically complex word. They were then asked to articulate the resulting word as fast as

possible. The source words were always existing words such as *mazkeret* 'souvenir'. Their roots (here Z-K-R) were either productive—roots that appear in many Hebrew words—or nonproductive—roots appearing in only one Hebrew word. The target stimuli were strings of consonant letters, forming neither real words nor even legitimate roots (e.g., C-K-R). The participants' task was to name the string of consonants using the word pattern of the source word. For example, with *mazkeret* as a source stimulus, they had to extract the pattern maCCeCet and to merge it with the target stimulus as if the latter were a legal root (e.g., *mackeret*). The researchers hypothesized that if the participants were sensitive to root morphemes it should be easier for them to detach word patterns associated with productive roots than patterns associated with nonproductive roots. As predicted, the targets were named faster when the roots of the source word segments were productive. The authors interpreted these findings to mean that Hebrew word identification includes a stage in which roots and patterns are decomposed. Naturally, the decomposition process becomes easier and faster when the sublexical elements are more frequent.

Masked Priming. An extensive research project on Hebrew word decomposition by another experimental method was conducted by Frost, Forster, Deutsch, and associates (Deutsch, Frost, & Forster, 1998; Deutsch, Frost, Pollatsek, & Rayner, 2000; Deutsch, Frost, Pelleg, Pollatsek, & Rayner, 2003; Frost, Deutsch, & Forster, 2000a; Frost, Forster, & Deutsch, 1997). The experimental design known as "masked priming" (developed by Forster & Davis, 1984) allows presentation of a target word preceded and succeeded by forward and backward masking. The first (forward mask) is simply a stimulus in the form of crosshatching (#####), used to erase the memory trace of any previous orthographic processing. In the study reported below this mask was presented for 500 ms. It then disappeared, and was replaced by a string of letters, sometimes a word (hereafter referred to as the prime) that was related in some systematic manner to the target word that was presented afterwards. The prime was shown for a very short time (around 50 ms) and was immediately followed by the target word, which also functioned as a backward mask because it terminated the processing of the prime.

As the appearance of the prime was so fleeting, and was terminated by the presentation of the target word, it allowed a limited amount of processing: visual (orthographic) and, possibly, some phonological processing, which evidently takes place within the initial 50 ms (Berent & Perfetti, 1995; Booth et al., 1999; Lee et al., 2001). It may not permit the otherwise ensuing semantic processing, and its presentation did not usually evoke a consciousness trace: participants could not tell the identity of the prime or even if there was one. Such priming is believed not to be sensitive to semantic factors, which take a

longer time to build up (cf. Forster, Mohan, & Hector, 2003). Hence, the prime, it is thought, facilitates only orthographic, phonological, and perhaps morphological processing, owing to the overlap of elements inside the prime and the target (but see Sereno, 1991; Gollan, Forster, & Frost, 1997).

Decomposing Hebrew Nouns. The first experiment of Frost et al. (1997) measured sensitivity to noun patterns. The masked priming presentation was employed in both lexical decision and naming tasks (see above). The two tasks were performed under three conditions. In the “related” condition the decision was made when the prime and the target shared the same pattern but not the same root, for example, *taklit* ‘record’ and *targil* ‘exercise’ (both of the noun pattern taCCiC). In the “control” condition, the prime and the target had different noun patterns, for example, *targil* ‘exercise’ and *tadhema* ‘surprise’. In the third, “identity,” condition, the prime and the target were identical. The main purpose of the third condition was to verify the effectiveness of the prime in an ideal setting of maximal overlap.

The lists of the targets included words and nonwords. The same set of stimuli and means of presentation were used in two experimental settings: once with a lexical decision task, in which the participants had to decide whether the target was an existing word or not, and once again in a naming task, in which the participants were simply asked to articulate the targets as quickly as possible. The time from the onset of the target to the participants’ reaction was recorded. In the following description only responses to real words are discussed.

The results indicated effective identity priming where the prime and the target were the same. But neither the lexical decision nor the naming task showed a priming effect when the target was preceded by a prime of an identical pattern but of a different root. Priming with identical pattern did not facilitate reading.

The second experiment, again focusing on Hebrew nouns, used the same experimental designs to assess sensitivity to the nouns’ roots. In the related condition a real root (e.g., Z-M-R, core meaning ‘singing’) primed the target word, for example, *tizmoret* ‘orchestra’, in which this root is incorporated. In the control condition, the prime was a string of three consonants, of which at least one was not part of the target’s root. The differences in reaction time between the related and the control conditions were not very large: 13 ms in the lexical decision task and 11 ms in the naming task, but they were found statistically significant. The results suggested that priming targets with roots did facilitate lexical access and naming of Hebrew nouns.

The study of Frost et al. (1997) is without doubt an important attempt at investigating the possibility of word decomposition in Hebrew. Unfortunately, it leaves some questions open. The first concerns the interpretation of the finding that priming Hebrew nouns with roots apparently facilitated the

nouns' recognition, but priming them with patterns did not. The authors implied that although roots and patterns are both abstract entities, roots have some core meaning that is shared by a number of words. By virtue of this, roots play a pivotal role in the semantic networks by which the Hebrew mental lexicon is organized. The roots, the authors claimed, "facilitate lexical access to a large cluster of words that are derived from them" and "they represent *primarily* families of words that explicitly or *implicitly share features of meaning*" (italics added). On the other hand, the patterns, they said, represent a "distinguished phonological form" but "may have relatively minor roles in accessing all words that are formed with them" (p. 842).

One problem with the authors' interpretation of their results is that it does not seem to be consistent with what they claimed to be the inherent nature of the masked priming paradigm. Masked priming, the authors maintained, is supposed to reflect the initial, perceptual aspect of word recognition; it allows no semantic processing. If so, the semantic role of roots as central nodes of semantic networks should have no effect. Indeed in one of the experiments (no. 5) of Frost et al. (1997), the authors demonstrated that root derivations can prime other derivations having the same root, regardless of their semantic relatedness; "morphological priming," they said, "occurs irrespective of semantic relatedness" (p. 841, see also Frost et al., 2000a, experiments 5). The question, then, is how a semantic effect surfaces in an experimental design that is not expected to engage semantic processing? In fact, from these data we may only conclude that the primes facilitated target recognition only on account of the overlap of identical root letters in the prime and the target—not on account of the root's meaning, as materialized by associations with other words that share the same root.

A more likely explanation for the results may be that the difference in priming effect between the root and the pattern is not because of the different role the two play in Hebrew words. It is because to the reader of Hebrew, roots and patterns have significant different appearances. Patterns are often discontinuous; they contain vowels and consonants before and/or after the root. For example, *ti-* at the beginning and *-et* at the end of the word *ti-ẓmor-et* 'orchestra'. Unlike the appearance of the pattern, the root letters generally appear (perceptually) as one unit. They appear, in fact, as one unit even when, orthographically, they are interrupted by a vowel letter or by metathesis, namely where, for phonotactic reasons, the first root consonant change places with the last prefix consonant, for example, *hištaḏel* 'made special efforts' instead of **hit-šadel*, which is in line with the *hitpa'el* pattern. Note that the root letters S, D, L maintain their order in spite of the *t* infix.

In addition, recall that in an unvoiced text usually no letter or diacritic mark breaks the visual contiguity or order of the root consonants. The exceptions are words in which a vowel letter (mostly *yod* or *vav*) is sometimes inserted between two root letters. In voiced text the diacritics appear below

or above the letters so that the continuity of the root letters is again rarely interrupted. When an interruption by a vowel letter occurs, its effect should not be overestimated because the Hebrew reader most likely recognizes the root with or without vowel letters as one and the same. This can be seen in the results of Experiment 4, in Frost, Kugler, Deutsch, and Forster (in press), where, for example, the root L-M-D effectively primed the target *talmid*, in spite of the intrusion of a vowel letter (*yod*) between two root letters. Therefore, roots may be endowed with more priming power than patterns because of differences in the orthographic structures of roots and patterns.

In other words, the primacy of roots over patterns as primes for Hebrew nouns seems to have a lot to do with the masked priming paradigm. Frost et al. (2000a) stated it clearly:

[F]acilitation in this paradigm reflects a transfer effect; that is, priming results from the fact that the processing carried out on the prime is transferred across to the target. This transfer is made possible when the prime and target have overlapping representations. (p. 754)

The question, of course, is what is transferred, or what potentially overlaps in the related condition. Under the conditions of the study by Frost et al. (1997), where primes and targets are presented visually as unvoiced words, the three consonant letters of the root that appear together, always in the same order, should be the first candidate. Thus roots, I suggest, are easily transferred from primes to targets not because of their semantic role, by which they govern the mental lexicon, but because of their visual features: sequential, contiguous, and familiar units. By contrast, the relatively weak priming effect of noun patterns may be due to their noncontiguous structure, with letters visually appearing before and after the root.

Secondly, although the sensitivity to root letters indeed facilitates the recognition of Hebrew nouns, such sensitivity may be necessary but not sufficient. It could be that the root letters evoke the word's stem, a combination of the root consonants and the vowels that are coarticulated with them, and only through recognition of the stem, as opposed to the semantically opaque root, is the word recognized. This possibility is particularly compelling considering that the Hebrew reader is accustomed to reading unvoiced words in a way that forces him or her to fill in the vowels through top-down processing. Frost (1998, 2003), as well as Berent and Perfetti (1995), Booth et al. (1999), and Lee et al. (2001), argued that initial phonological decoding starts very early, within the first 50 ms of reading. If so, we should leave open the possibility that the root letters themselves trigger recognition of the word stem, which, unlike the root, is pronounceable and meaningful. Only then, I suggest, after recognition of the word's stem and the affixes, if present, is the full word identified and comprehended. Importantly, in the synthesis stage of

word decomposition, the affixes, if present, are synthesized with the base or the stem, not with the root.

This suggestion is not inconsistent with the decomposition theory; it only portrays the recognition-by-decomposition process differently, attributing different roles to the sublexical elements. It recognizes the stem and the affixes—not just the root and the pattern—as the “governing elements” in the processing of Hebrew words.

Decomposing Hebrew Verbs. A complementary study to that of Frost et al. (1997) was published a year later by the same authors: Deutsch, Frost, and Forster (1998). This study focuses on the verbal system, and attempts to examine the priming effects of roots and patterns on Hebrew verbs, using the masked priming procedure described earlier.

In their 1998 study, these researchers rightly stated that nouns and verbs should be examined separately because of some important differences. These, the authors suspected, may be expressed in the different impact or the roles roots and patterns play in governing word processing in different word groups.

In the study, the masked priming design described earlier likewise had identity, related, and control conditions. The first experiment assessed the priming effect of verb patterns. In the related condition, the researchers primed targets with verbs having the same pattern as the target word but a different root. In the control condition, the prime and the target had different patterns and different roots. In the identity condition, again, the prime and the target were identical.

The critical test was the difference between the related and the control conditions as measured in reaction time and error rates, in both lexical decision and naming tasks. The differences in reaction time again proved not very large (14 ms in the lexical decision task and 11 ms in the naming task), but they were found statistically significant. Thus, unlike the findings of Frost et al. (1997) in their search for priming effect of patterns in Hebrew nouns, the findings of this study indicate that verb patterns effectively prime Hebrew words.

The very same results emerged in the second experiment, with what may be called “potential words.” These are words having a legal Hebrew root and a legal Hebrew pattern, except that these particular combinations of roots and patterns are not used in contemporary Hebrew (cf. Goral & Obler, 2003). In Experiment 3, Deutsch et al. (1998) found that the roots were also effective primes for Hebrew verbs.

The overall results confirmed the authors’ expectation that roots and patterns may have different roles in different word groups. Unlike in the nominal system, in the verbal system not only the roots but also the patterns behave as effective primes, attesting to sensitivity of Hebrew speakers to these morphemes.

In interpreting their 1998 data in an attempt to explain the different results in priming nouns and verbs, Deutsch and colleagues pointed out three differences between the nominal and the verbal systems. The first is quantitative in nature. Whereas the number of nominal patterns, they said, is very large (above 100), the number of verb patterns is only seven. This account may be misleading. True, Hebrew has seven verbal classes, *binyanim*, but every *binyan*, in fact, is a class of patterns. Such classes of patterns do not exist among noun patterns. Remember that verbs are conjugated to mark person (first, second, or third), number (singular or plural), gender (masculine or feminine), and tense (past, present, or future). Some also include conjugations of the imperative, and there is the infinitive form as well. These distinctions are marked by a variety of verbal patterns. All told, the number of distinct word patterns in one verbal class approaches 30, and the number of distinct patterns in all seven *binyanim* is far above 100—not much different from the number of noun patterns (*mishkalim*), which are not grouped in classes.

Parenthetically, if the number of patterns explains their effectiveness as primes, a small number being more effective, how can we account for the finding that in both the nominal and the verbal systems the large number of roots (many thousands) does not decrease their effectiveness as primes?

An alternative interpretation may rest on another feature of the verbal system: the high rate of morphemic, and orthographic, redundancy in verbal patterns. This redundancy may be observed in the initial and the final verb ends—affixes of Hebrew verbal patterns, as is shown below.

In the cohorts of distinct patterns in the seven verbal classes (*binyanim*), invariant affixes are clearly evident. Examples of such productivity are the suffixes *-ti*, and *-ta* in the conjugation of past tense, first person singular and second person masculine singular; and *-nu*, and *-tem* (or *-ten*) in past tense, first and second person masculine (or feminine) plural, as well as the suffix *-u* in future tense, third person masculine plural in all seven *binyanim*. Here are some examples with the root K-T-L (core meaning: to kill) in the seven *binyanim*. Note the high productivity of inflectional suffixes across *binyanim*, and the high productivity of derivational prefixes between *binyanim*.

	pa'al	ni'fal	hi'fil	hu'fal	pi'el	pu'al	hitpa'el
Sng. 1st m/f. past:	katal-ti,	ni-katal-ti,	hi-katal-ti,	hu-katal-ti,	kital-ti,	kutal-ti,	hit-katal-ti
Sng. 2nd m. past:	katal-ta,	ni-katal-ta,	hi-katal-ta,	hu-katal-ta,	kital-ta,	kutal-ta,	hit-katal-ta
Pl. 1st m/f. past:	katal-nu,	ni-katal-nu,	hi-katal-nu,	hu-katal-nu,	kital-nu,	kutal-nu,	hit-katal-nu

The high productivity manifested in the verbal system, but not nearly so much in the nominal system, makes the classes of verbal patterns a real inflectional system (Aronoff, 1994). It seems reasonable that this high productivity of prefixes and suffixes, not the number of patterns, is what explains the high sensitivity to verbal patterns among Hebrew speakers. Although the patterns of verbs, like those of nouns, are disrupted by the consonantal root,

and they differ in a variety of vocalic structures, the highly productive verbal affixation (compared with nominal affixation) makes patterns easier to recognize in verbs than in nouns.

To summarize, an important contribution of the studies reported by Frost, Deutsch, Forster, and associates is their demonstration that the root as a sublexical element has an independent effect, unconstrained by semantic mediation. This conclusion was further supported by eye-movement studies conducted by the authors in collaboration with Rayner and Pollatsek (Deutsch et al., 2000, 2003). From the findings of these studies it seems reasonable that the priming effect of the roots and the patterns (in the verbal system) is restricted to their orthographic features—the overlapping features that are transferred from the prime to the target.

Altogether, this series of studies suggests that the root is independently represented in the mental lexicon, and its automatic recognition perhaps triggers the process of word recognition in Hebrew. This conclusion, however, must be approached with caution. According to these authors' view of the masked priming paradigm, this method of experimentation opens an interesting but nevertheless narrow window onto the entire process of word comprehension. What can be seen through this window is the very initial step of word recognition—the visual perceptual processes of reading a word, and apparently some phonological processing (not examined in these studies). As noted, from these initial steps to complete word comprehension there is some distance. For complete word recognition, additional activation of associations, which recover the syntactic and semantic facets of the word, is to be expected. In real life (as opposed to single word recognition in laboratory studies) word recognition also requires a computation that takes into account knowledge of the situation in which the word appears. More research is needed for learning about the advanced stages of word recognition. A recent initial contribution in this direction in a study on Arabic is provided by Boudelaa and Marslen-Wilson (2005).

Cross-Modal Priming—The Onset of Semantic Processing. It is in this regard, namely the advanced stages of processing words, that another study by these researchers (Frost et al., 2000b) enters the picture. The experimental paradigm of this study is similar to the masked priming described earlier, except that the prime is heard, not seen. It is sounded in the participants' ears instead of being shown before their eyes on the screen prior to the target word. This experimental design is known as cross-modal priming. In contrast to masked priming, having the prime heard may provide new information on sensitivity to sublexical elements due to (a) the direct and overt presentation of the prime's phonology, and (b) the significantly longer prime presentation. Under visual masked priming, phonological processing can start only after some orthographic processing has been performed successfully and the graphemes are translated to phonemes, but in cross-modal priming with au-

ditory primes the phonological values of the prime need not be retrieved by grapheme-to-phoneme associations; they are provided straightaway. This allows immediate semantic processing through association between speech and meaning.

Unlike the unimodal (visual) masked priming presentation, where the visual prime takes a very short time, presentation of the heard prime with cross-modal priming must take at least the length of time needed for articulation. This is several times longer than the 50 ms period of visual prime presentation. Therefore unlike the short visual presentation, the auditory presentation cannot but engage the processing that leads to word comprehension.

The first experiment conducted by Frost and associates (2000b) investigated pattern priming of both nouns and verbs. In the related condition, a prime such as *maqhela* 'a choir' preceded a target such as *mazmera* 'pruning shears', both having the maCCeCa pattern. With verbs, a prime such as *husbar* 'was explained' preceded the word *hugdar* 'was defined', both having the pattern hu-CCaC. The results indicate highly significant pattern priming with verbs, and marginally significant pattern priming with nouns. These results accord with those of Deutsch et al. (1998) in supporting pattern priming in verbs, and, unlike the findings of Frost et al. (1997) suggest the possibility of a pattern priming effect with nouns, perhaps to a lower degree. Whether the increasing pattern effect in nouns is a result of the longer exposure to the auditory prime or of the explicit phonological presentation, or of both, is a matter for speculation as these factors are clearly confounded.

More interesting perhaps is Experiment 2 of this study where the effect of priming with roots was examined. The experimenters took advantage of the fact that Hebrew nouns that share the same root are sometimes semantically unrelated (as discussed previously regarding Bentin and Feldman's (1990) study). In one version of the experiment, the prime and the target had the same root and also shared a core meaning, for example, *madrix* 'a guide' and *hadraxa* 'guidance'. In another version the prime and the target shared a root but were semantically unrelated, for example, *drixut* 'alertness' and *hadraxa* 'guidance'. The results suggest a strong priming effect under morphological (root) and semantic relatedness of prime and target, and a weaker one (by 16 ms), yet still significant, under the condition of shared root but no semantic relation.

The results of this study also converge with prior studies such as Deutsch et al. (1998) in indicating priming effect due to a shared root. Importantly, in this study such an effect is not constrained by semantic relatedness, for it was obtained even without semantic relatedness of prime and target, although to a smaller extent. However, the results also demonstrate that in conditions created by cross-modal priming a semantic relation between the root-prime and target significantly strengthened purely morphological priming. Once

again, whether the evident semantic processing in this task is made possible by the prolonging of prime exposure or by the explicit phonological presentation transmitted by the prime is not clear.

An intriguing question stemming from this study is whether a semantic factor is to be found even in the visual masked priming setting discussed earlier. If it is, this would justify reexamination of the basic assumptions underlying our understanding of masked priming, allowing the possibility of more than perceptual processing under masked priming conditions (cf. Gollan, Forster & Frost 1997). If not, and if the increasing latency of the auditory prime is responsible for the significant semantic factor in cross-modal priming, then for semantic priming to have an effect the prime must presumably be exposed for more than the short period of 50 ms.

Finally, although the authors emphasize that masked priming reflects sensitivity to lexical (and sublexical, morphemic) elements in priming Hebrew roots and patterns, the evidence from masked priming studies in other languages indicates that masked priming effect may result from a number of factors, in fact, from every attribute of written words. There is evidence showing masked priming effect of prelexical, orthographic factor (Bowers, Vigliocco, & Haan, 1998), which shows that readers seem to encode letters as abstract entities. For example, in priming upper case letter strings, the priming effect of lower case letters that are similar in shape to the upper case letters (e.g., sock-SOCK) is not significantly different than the priming effect of lower case letters that are not visually similar to the upper case letters (e.g., glad-GLAD). It is therefore believed that it is not only the overlapping visual features of the letters but their more abstract identity, which subsumes both the lower and the upper cases (and perhaps their phonological connotation), that explains orthographic priming effect.

Phonological masked priming was demonstrated by Shen and Foster (1999) in priming Chinese characters with other Chinese characters that have identical sound but different shapes. Semantic effect in masked priming experiments is particularly interesting: In repetition priming, where the prime and the target had a high degree of orthographic overlap (e.g., mother-both-er), no priming effect was found, indicating that semantic incongruence has a stronger effect than orthographic similarity (Colombo, 1986; Martin & Jensen, 1988). But when the primes were masked, reliable facilitation effects were observed (Forster, Davis, Schoknecht, & Carter, 1987). These results indicate that unlike unmasked priming, masked priming is primarily sensitive to sublexical forms such as letters and orthographic clusters. Simple, unmasked, priming allows complete word recognition and hence is more sensitive to semantic factors. However, in a later study, Gollan, Forster, and Frost (1997) demonstrated semantic effect even in masked priming with bilingual readers whose reading of English words was facilitated by masked primes consisting of Hebrew translations of the target words (and vice versa).

All in all, in the masked priming studies of Frost et al. (1997) and Deutsch et al. (1998), where Hebrew roots as masked primes facilitate the reading of Hebrew words in which such roots are embedded, it is not obvious if the facilitating factor is orthographic, phonological, morphological, semantic, or, most likely, a combination of some or all of these. Each and every one of these factors may potentially facilitate the reading of the target words to some extent, depending on the stage of processing and the amount of processing allowed by the experimental conditions.

Sensitivity to the Root's Characteristics. Berent and Shimron, together with a number of associates, examined in successive studies sensitivity to the root in Hebrew from another angle and by a different experimental approach (Berent, Everett, & Shimron, 2001; Berent, Marcus, Shimron, & Gafos, 2002; Berent & Shimron, 2003; Berent, Shimron, & Vaknin, 2004; Berent, Vaknin, & Shimron, 2004). Basically, these studies assume that if Hebrew speakers are sensitive to the root as an independent constituent of Hebrew words, they should ipso facto be sensitive to the root's idiosyncrasies or restrictions. In our first study (Berent & Shimron, 1997), we took the constraints of consonant gemination (duplication), discussed in McCarthy (1986; see chapter 2), as our starting point for examining Hebrew speakers' perception of the root as an independent morpheme in Hebrew words.

We may recall that in most Hebrew roots the location of geminates in the root is markedly asymmetrical. We have observed that root-final gemination is quite frequent, and root-initial gemination is extremely rare. In fact, there are only five roots with root-initial gemination (M-M-N, M-M-Š, D-D-H, K-K-B, and N-N-S), of which only two are in fact productive (M-M-N and M-M-Š). We applied McCarthy's Obligatory Contour Principle (OCP) theory (McCarthy, 1979, 1986; see chapter 2) as an explanation for the asymmetry.

To recap, the OCP bans identical adjacent consonants in the mental lexicon. Roots that appear to have duplication of one consonant in the two final slots (e.g., MSS) are presumably stored in the lexicon as biconsonantal roots (e.g., MS). However, when inserted into the canonic three-slot pattern, the root must be aligned with the pattern from left to right (in Hebrew, from right to left). Such an alignment leaves one of the three slots unoccupied. To fill this empty slot, the second (last) consonant often duplicates itself by spreading to the last open slot, so that the result is final doubling (e.g., MSS).

Such an explanation enjoys the advantage of being based on a fundamental principle of phonology, not tailored particularly to the analysis of Hebrew word structure. In exploiting the asymmetry of gemination patterns to assess Hebrew speakers' sensitivity to the Hebrew root, we (Berent & Shimron,

1997) asked whether Hebrew speakers judged roots with initial gemination as less appropriate for novel Hebrew word formation.

We used two tasks, production and rating. In the first, speakers were asked to generate words from existing roots. They were presented with a novel (nonexistent) root and a word as an example. Their task was to conjugate the nonroot by analogy with the presented exemplar. To accomplish the task, the participants had to extract the root from the exemplar and replace it with the nonroot. Among the nonroots, some had three radicals, all different consonants, to which no constraints were applied; others had just two radicals. With these biradical consonants, to accomplish the task, considering the three-slot structure of the Hebrew pattern, subjects would normally add one consonant. They could add a new consonant or double one of the two consonants presented to them. According to the constraints discussed previously and OCP theory, we expected Hebrew speakers to double one of the radicals, and predicted that the root-final gemination would occur more frequently than root-initial gemination. These predictions were fully borne out. Root-initial gemination amounted to less than 1% of the correct responses, whereas root-final gemination reached about 46%.

In the rating task, speakers assessed the acceptability of words derived from three types of nonroots, one with root-initial gemination, one with root-final gemination, and one with no gemination at all. Our participants were asked to rate the acceptability of the nonword patterns in which these three types of nonroots were inserted as if they were candidates for new Hebrew words. The results showed significantly lower ratings for root-initial gemination than for root-final gemination. This pattern emerged regardless of the location of the root in the word in three different *mishkalim* and a variety of conjugation types. Thus, rejection of root-initial gemination, as an indication of acquaintance with the root as a sublexical element, could not be explained by its location in the word. The findings suggested that the speakers recognized the root as an independent unit.

In conclusion, both our experiments provided strong support for OCP theory, and converged with other studies such as Bentin and Feldman (1990), Deutsch et al. (1998), and Frost et al. (1997), in demonstrating Hebrew readers' sensitivity to the root as a sublexical unit. Such results are consistent with a root decomposition hypothesis, which cannot be assumed unless the subjects are sensitive to or familiar with sublexical units of Hebrew words. Importantly, although the tasks performed in these studies had no time constraints, when participants were asked to explain their rejection of root-initial gemination they were unable to do so. Accordingly there is no reason to attribute conscious awareness or a schooling effect to these findings. They suggest instead that readers' sensitivity to the root is part of their basic conception of Hebrew words.

In further studies of sensitivity to Hebrew roots by way of sensitivity to the OCP constraints, Berent, Everett, and Shimron (2001) employed a production task designed to mimic the formation of root geminates. In the first experiment the question was whether, in conjugating a biconsonantal root, Hebrew speakers would duplicate consonants, and, if they did, would they prefer final gemination to initial gemination. They were presented with an invented biconsonantal root and asked to conjugate it according to the regular model of the triconsonantal root. To perform the task, the participants had to recover the pattern of the exemplary word and then incorporate the biconsonantal root into the recovered pattern. Participants could either conjugate the new root as given, namely as a biconsonantal root, or add a third consonant to the root. If they chose the latter course they could either duplicate the final consonant or the first consonant, or add a new consonant altogether. Only the first option would demonstrate sensitivity to the OCP constraint on the production of Hebrew words. Of the total responses, about 47% reflected a preference for root-final gemination, whereas root-initial gemination was preferred in less than 3% of the conjugations, again supporting our prediction.

The studies reviewed so far aimed at examining Hebrew speakers' conceptions of Hebrew words through their sensitivity to the root as a central unit. In another study Berent, Shimron, and Vaknin (2001) examined the more direct implications of this sensitivity for reading. In a lexical decision task, the participants were asked to decide whether a particular string of letters was an existing word or not. The stimuli presented to the readers were words and nonwords built with the same word patterns. But the nonwords' roots had three-consonant combinations that do not exist in Hebrew. These nonroots exhibited root-initial gemination, root-final gemination, and no gemination, for example, GGS, SGG, and NGS. We predicted that root-initial gemination, which is awkward, would be the easiest to reject, the root with no gemination would be the hardest to reject, and root-final gemination would be somewhere in between. The words and the nonwords matched existing Hebrew word patterns; in the first of our experiments the word's base was not affixed (e.g., GaGoS), in the second it was suffixed (e.g., GaGoS-tem), and in the third it was both prefixed and suffixed (e.g., hit-GaGaS-ti). The results of all three experiments confirmed our expectation with regard to nonwords with root-initial gemination. The rejection of these forms was indeed significantly faster than the rejection of the two other kinds of nonwords. There was no significant difference between the reaction time to nonwords with final gemination and to nonwords without gemination. Similar results were obtained by Berent, Marcus, Shimron, and Gafos (2002). Here the stimuli (Hebrew words and nonwords) were presented with English letters. The geminates were consonants that do not represent phonemes in the traditional Hebrew stock, for example, the Eng-

lish /j/. All this notwithstanding, the participants proved sensitive to the general OCP constraints on gemination of consonants in Hebrew roots.

In summary, our findings on Hebrew speakers' sensitivity to duplication (gemination) constraints in consonantal roots seem quite robust, being replicated in a number of different experimental designs. They seem to provide strong support for the claim that Hebrew speakers are sensitive to the root as a sublexical unit. These results are consistent with the studies reported earlier in this chapter that demonstrate the sensitivity of the Hebrew speakers to the root.

In addition, remember that McCarthy's explanation of gemination asymmetry, namely the rarity of initial consonant gemination and the ubiquity of final gemination rests on the assumption that within the Hebrew word's base the consonants and the vowel pattern are in fact separately represented in the mental lexicon, as if set on different tiers. Importantly, some new empirical evidence seems to support the assumption that consonants and vowels are differently processed (e.g., Berent & Perfetti, 1995; Lee et al., 2001). This evidence suggests different processing stages of consonants and vowels in the very early stage of word recognition, indicating that consonants are recognized earlier than vowels. However, this empirical evidence has not yet been replicated with Hebrew or any other Semitic words. Such an examination seems complicated, because (a) when unvoiced Hebrew text is read most vowel information is not indicated in the line of the text; (b) with both voiced and unvoiced texts, part of the vocalic information is indicated via the vowel letters, which are ambivalent in that they can serve as vowels and consonants; and (c) in the voiced text, most vowel signs are represented by diacritics (points and short strokes), mostly placed below the consonant letters, but sometimes above and sometimes inside the letter. Because vowel and consonant letters do not appear in the text in the same way, a test of the differential presentation of consonants and vowels in the mental lexicon may be problematic. Still, the demonstration that consonants are processed differently from vowels in Semitic word structure appears to furnish a missing part of the puzzle.

Another issue concerns the processing of biconsonantal roots, particularly the notion that the roots with final consonant gemination are represented in the mental lexicon by a biconsonantal root, and that gemination is performed online, as it were, whenever such bi-consonantal roots are inserted into the canonic word pattern. To be convincing, empirical evidence for this hypothesis cannot rest exclusively on data derived from the processing of nonwords. In addition, it seems hard to imagine that final-geminated roots of frequent words are actually represented as biradicals roots in the mental lexicon. The fact that participants in these studies judged nonwords with initial gemination as less likely to occur in a Hebrew words, or that they mostly duplicated final consonants of biradical nonwords, does not necessarily imply

that Hebrew speakers employ this very procedure in processing existing, particularly frequent, Hebrew words. We need to examine whether words with final gemination roots are processed differently than words having no gemination.

To conclude, the entire series of studies about Hebrew speakers' sensitivity to the OCP constraints on Hebrew roots harmonize with those of Frost, Deutsch, and Forster and their associates, as well as with earlier studies of Bentin and Feldman and later ones by Feldman and Raveh (2003), and Goral and Obler (2003). Together they make a strong case for the argument that Hebrew speakers are sensitive to the roots (and in some cases patterns) that are embedded in Hebrew words presented in speech or in reading. As noted earlier, sensitivity to roots is also found among preschoolers in language acquisition studies.

Affixation in Hebrew

So far, we have found evidence of Hebrew speakers' sensitivity to two sublexical elements, the root and the pattern. However, as noted in chapter 2, roots and patterns are not the only elements (morphemes) of Hebrew words. Verbs may be segmented into bases or stems, and optional derivational and inflectional affixes, and nouns are affixed to mark plurals, and sometimes gender. Research on Hebrew speakers' sensitivity to bases, stems, and affixes is still in its infancy. Some research on affixation in the process of number (plural) inflection of Hebrew nouns is reported below.

Number Inflection

As elaborated in chapter 2, we have noted two kinds of plural suffixes in Hebrew nouns: one for inflecting masculine nouns, the other for feminine (all Hebrew nouns are either feminine or masculine; there is no neuter). Masculine singular nouns are unmarked; by way of elimination, they may be characterized as having none of the feminine markers. Feminine nouns are generally marked by certain word endings such as *-a* as in *yald-a* 'girl', *-at* as in *calax-at* 'dish, plate', *-et* as in *rakev-et* 'train,' *-it*, as in *rakdan-it* '(female) dancer', and *-ut* as in *acma'-ut* 'independence'. There are, however, quite a number of gender irregularities, namely, grammatically feminine nouns that are unmarked, like the masculine form. Hence a noun's gender is typically of very low productivity.

As for number inflection, the masculine plural suffix is *-im*, as in *šir—šir-im* 'song-songs' or *yelad—yelad-im* 'boy-boys'. The feminine plural suffix is *-ot*, as in *sira—sir-ot* 'boat-boats' and *yalda—yelad-ot*, 'girl-girls'. We have also

seen that a plural inflection sometimes entails a vocalic change in the word's base.

However, here again a number of irregularities exist. Some feminine nouns are made plural with a masculine suffix and some masculine nouns with a feminine suffix. Examples are *beyca*—*beyc-im* 'egg-eggs' (fem.), as opposed to the regular *leyda*—*leyd-ot* 'birth-births' (fem.); or *xalon*—*xalon-ot* 'window-windows' (mas.), as opposed to the regular: *balon*—*balon-im* 'balloon-balloons' (mas.). Consequently, a large number of nouns may be viewed as irregulars. Note that irregularly inflected Hebrew nouns are not grouped by morphological and phonological structures, such as the English *sing*—*sang*, *ring*—*rang*, or *blow*—*blew*, *know*—*knew*; Hebrew words built with the same pattern may be regularly or irregularly inflected, for example, *sir*—*sir-im* 'pot-pots', but *kir*—*kir-ot* 'wall-walls'; both nouns are grammatically masculine, but the first is inflected with the masculine suffix and the second with the feminine suffix.

In addition, the singular form may not be typical of its gender. As stated, a feminine singular may be unmarked, and therefore looks masculine, for example, *gefen*—*gfan-im* 'vine-vines' (fem.), where both the singular and the plural are grammatically feminine but morphologically they appear as masculine. It can also be that the singular word has a masculine form, not typical of its gender, but the plural form accepts the correct suffix, for example, *kikar*—*kikar-ot* (fem.) 'town square' or 'loaf of bread'.

The only way to determine the noun's gender is by checking the grammatical agreement between the noun and its adjectives, which are never irregular. Adjectives are always faithful to the noun's grammatical gender. So the irregularity of the feminine singular *beyca* 'egg' (plural, *beyc-im*) is exhibited when it appears with the adjective "big": *beyc-a gdol-a* 'egg big = big egg'; *beycim gdol-ot* 'eggs big = big eggs' (both singular and plural adjectives have feminine endings).

Because of the variety of feminine markings and the many irregular plural forms, the status of plural inflection in Hebrew nouns is justly questioned with regard to its productivity. Aronoff (1994) maintained that noun inflection in Hebrew is not paradigmatic but idiosyncratic. However, what is defined by linguists as nonproductive and idiosyncratic may allow some insight in unfolding the mechanism of inflections, as is shown later. As in other fields of psychological research, irregularity (or abnormality) is often a blessing.

An interesting issue here is that despite the existence noted earlier of a considerable number of irregular plural inflections of Hebrew nouns, most native Hebrew speakers rarely err in their inflection. One naturally wonders what kind of psychological mechanism can explain plural inflection, in respect of its nonproductivity, on the one hand, and Hebrew speakers' linguis-

tic competence on the other. Another issue is the role of a default procedure in Hebrew number inflection. A default procedure is defined in this discussion as automatic production of inflections in a lawful manner, such as attaching the grammatically correct plural suffix to a base word. A default is supposed to work well where inflection is relatively productive, but will often be counterproductive where inflections are of low productivity.

To answer these questions one needs to take into account what is stored in Hebrew speakers' mental lexicon, and how the stored elements are manipulated to produce noun inflections. If plural inflection is entirely idiosyncratic, and no default is activated, it seems reasonable that all singular noun forms, regulars and irregulars, should be stored in the mental lexicon, linked to their respective plural forms. Number inflection would then be attained by activating the association between the singulars and their plural forms. If so, and provided of course that frequency is controlled, regular and irregular noun inflections should not differ in terms of latency of inflections or error rate.

If, on the other hand, number inflection is also executed by automatic (default) affixation governed by linguistic rules, then the large number of irregulars notwithstanding, the mental lexicon should also contain stems and plural suffixes to facilitate processing by default. Regular nouns should then be inflected by suffixation according to their gender, whereas irregular nouns should be inflected by their links (associations) to their respective plural forms in the mental lexicon. The interesting question with regard to the inflection of irregulars, as we shall see below, is whether their inflection is affected by the default automatic processing.

But why do we need to assume a default procedure in the first place, if perhaps all kinds of inflections, regular and irregular, are stored in the mental lexicon? There are at least two observations that justify such an assumption. First, people understand inflected words even when these have not been previously encountered. For example, English speakers understand that a word like "stealer" means 'someone who steals' even though they have never encountered it because another word in English connotes the same meaning. Similarly, children commit "educated errors" when they say 'I goed' or 'I thinked'. Such errors must reflect morphological knowledge and, evidently, the ability to combine morphemes in inflecting words.

The second observation is that when languages accommodate a new word, it can be easily inflected. For example, the word "fax" became a household word in English and in Hebrew not too long ago, but soon after it was readily inflected as a noun and a verb. Apparently, language users possess morphological knowledge, which is reflected in the activation of default operations from a very early age.

However, several questions arise when we presume two mechanisms of word inflections. First, if two inflectional procedures are at work, one for inflecting regulars and the other for inflecting irregulars, assuming that irregular

inflections are fully stored linked to their singular forms, how are regular inflections stored in the lexicon? Are they stored as bases and stems only, together with a small number of affixes with which they are inflected? Or in addition, are regular inflections also stored in the mental lexicon as whole words?

Alternatively, if regulars and irregulars are processed by different mechanisms, how does the system ascertain that a certain singular noun is regular or irregular? In Hebrew there is nothing in a word's morphology or phonology that flags regularity or irregularity. Third, suppose the system does not know which is which, and launches the two procedures simultaneously for inflecting every noun: How does parallel processing of inflections affect the inflection of regular and irregular nouns? The research described in the following focuses on these issues.

Few research projects examined plural inflection in Hebrew nouns (Berent, Pinker, & Shimron, 1999, 2002; Gollan & Frost, 2001; Vaknin, 2000, 2004; Vaknin & Shimron, 2003). Berent et al. (1999) investigated the existence of a default procedure in plural inflection of Hebrew masculine nouns. In relation to the previous discussion, it was noted that although most masculine-sounding nouns take the regular *-im* suffix for the plural, neither their gender nor their plural suffix can be reliably determined from their surface form. Word patterns, *mishkalim*, provide little help in predicting regularity. The phonological clusters occupied by irregular nouns are largely shared with regular nouns. In addition, some masculine-sounding nouns are in fact feminine, and their inflection takes the *-ot* suffix (e.g., 'erec—'aracot, 'country'). There is also a large set of masculine-sounding nouns whose inflection is irregular in that they take the *-ot* suffix (e.g., *zug*—*zugot* 'pair').

The rationale for the 1999 study was based on Pinker's (1991, 1999) word/rule model, which assumes that regular nouns are inflected by a rule that requires identification of the stem and attachment of a proper suffix to it, whereas irregular nouns are inflected by association. Such a model implies that if a regular inflection is achieved solely by the rule, which operates like a default mechanism, then the inflection should be insensitive to similarity effect. A similarity effect is measured by presenting nonwords whose similarity to existing words is systematically controlled. High similarity is produced with nonwords in which one consonantal phoneme of the source (real) word is replaced by a consonant that is articulated in the same place in the vocal tract (e.g., *tsinor* 'pipe'—*tsilor*, both /n/ and /l/ are articulated with the tip of the tongue constricting the air stream just below our teeth). Medium similarity is achieved with nonwords in which one consonant of the source word is replaced by a phoneme that is not articulated in the same place in the vocal tract (e.g., *tsinor*—*tsikor*); finally, similarity is almost totally eliminated by replacement of all consonants (e.g., *tsinor*—*bikov*).

Unlike regular inflections that are accomplished by default affixation and do not require memory search, and therefore are not expected to evince sim-

ilarity effect, the inflection of irregular nouns according to the word/rule model was assumed to be obtained by a search in the associative store, so it should be affected by immediate associations in memory, including similarity to existing words. The more similar the nonword to an existing irregular noun, the more likely it is that the word will be inflected like the existing word.

The participants in the first experiment of Berent et al. (1999) were presented with a list of nonwords on paper, and were asked to write a proper plural for them. The results confirmed the hypothesized expectation: Inflection of irregular masculine nouns was found sensitive to the similarity effect, but that of regular nouns was not. These results are consistent with the view that the plural inflection of irregular nouns is achieved by associative process and that of regular nouns by linguistic rules.

In further analysis of the results, aimed at explaining the rule-like behavior, Berent et al. (1999) found that the regular words according to which the nonword stimuli were cast had on average more regularly inflected nouns (*friends*) in their group (*mishkal*) than irregularly inflected words (*enemies*). That finding perhaps means that although the *mishkal* contains both regular and irregular nouns, their distribution has some effect on Hebrew speakers' tendency to inflect the nonwords as regular or irregular masculine nouns.

It was also suggested that the presence of a large number of irregulars in a certain word group (*neighbors*) activated the associative mechanism of irregular inflection, and thus overrides the default process. However, our findings also reflected competition from regular "neighbors". Specifically, there was a correlation between the selection of irregular inflection for irregular-sounding nouns and the number of regular neighbors. The presence of a relatively large number of regular "friends" apparently interfered with the associative process of irregular inflection. This conclusion is consistent with similar results in English (e.g., Ullman, 1999), and also with the model suggested by Vaknin (2000, 2004, see below). It demonstrates the power of the default to subvert inflection by memory search.

In all, this experiment found strong evidence for the power of a rule-like (default) behavior in the inflection of Hebrew nouns. Apparently, a rule-like, default, procedure not only governs regular inflection but also interferes with the inflection of irregulars.

The second experiment of Berent et al. (1999) examines the inflection of nonwords that were highly dissimilar to existing Hebrew words. The rationale for this experiment was that assuming default processing to be activated automatically, idiosyncratic word forms, similar to no existing words, should be inflected by the regular default inflection. The results indeed showed that idiosyncratic words were inflected as regulars in more than 75% of the trials. Moreover, Hebrew speakers were found to apply default inflection to idiosyn-

cratic nonwords at a similar rate to their applying default inflection to nonwords that were highly similar to regularly inflected words. So it is very likely that a masculine-sounding novel word will be inflected by the default *-im* suffix.

The final experiment of Berent et al. (1999) examines the inflection of frequent Hebrew masculine nouns inserted into sentences as names for objects not usually associated with them, or as words borrowed from a context completely different from that of the objects normally expressed by these words. For example, the Hebrew masculine noun for a 'wall' is *kir*, and its plural inflection is irregular: *kir-ot*. But in the borrowed condition, *kir* was made to stand for a French drink. Similarly, as one of a list of names, this noun was inserted into a sentence as the surname of a French friend. The results suggest that irregular masculine nouns, when taken wholly out of its regular context and presented as borrowed names for objects or as people's surnames, were significantly less likely to be inflected irregularly. Rather, they were inflected as regular masculine-sounding Hebrew nouns.

In interpreting the results of this third experiment, Berent et al. (1999) suggested that names and borrowings lack a "canonical root"; as a result, they fail to activate the associative mechanism, and take a regular default inflection instead. The idea behind this theory is that a canonical root contains the information about the gender of the noun. Without this information, irregular nouns will be inflected by the default. This interpretation (elaborated in more detail in Berent et al., 2002a, p. 465) suggests that a consonantal root, termed a "root melody," be distinguished from a "canonical root," which carries the information about the root's idiosyncrasies.

In retrospect, I see several problems with this interpretation. First, it is not clear how a canonical root is represented in the mental lexicon in any different way from that of the consonantal root. Equally unclear is the relationship between the putative two kinds of root: For example, can we have one without the other?

Second, and perhaps more troublesome: as noted in chapter 2 noun inflection is not conditioned on having a root. Although every Hebrew noun can be inflected for number, not every Hebrew noun has a root. In the foregoing example the word *kir* 'wall' is one such noun without a root. It does, however, have a plural inflection and may be classified as belonging to a certain noun form, *mishkal*. Other examples are *šulxan* 'table', *kise* 'chair', and *xalon* 'window'—all very frequent (but rootless) nouns. How then does a noun without a root (of any kind) contain information about regularity?

Finally, until merged with a pattern, the canonical root is rightly perceived as ambiguous and opaque, in terms of phonology, syntax, and meaning. It seems equally opaque with regard to regularity, particularly because the same root is embedded in different nouns, some of them regulars, others

not. For example, the root D-M-H is embedded in the regular noun *dimuy* ‘image’ and the irregular noun *dimyon* ‘similarity.’ So even if a canonical root is psychologically real, as a different entity from the consonantal root it is likely to be ambiguous with regard to regularity.

In my opinion, the solution to these problems is that it is not the root (however defined) that governs number inflection, but the word base (as in many European languages). The base, which is not ambiguous in any respect, is also unambiguous with regard to the information about inflection. Remember that in the base, where the root is combined with a vocal pattern, the ambiguity of the root is generally resolved, phonologically, syntactically, and semantically (the exceptions are a small minority group of homographs). Accordingly, in a word decomposition process the word’s base (or stem), which combines the root’s consonants with the vowel pattern, and has an unambiguous pronunciation, a specific meaning, and clear syntactic restrictions, carries the information according to which inflections are performed. This interpretation is in line with the claims cited earlier in this chapter by Gafos (2003) and others with regard to Arabic.

Why then, when an irregular masculine noun like *kir* ‘wall,’ is presented as a borrowed noun or a surname, is its plural inflection accomplished by the default masculine suffix, regardless of how the homophonic (and homographic) Hebrew noun is inflected? Apparently, no plural inflection in Hebrew may disregard the noun’s grammatical gender. However, novel words and borrowings have no predetermined grammatical gender, and surnames, standing for families, never have grammatical gender. As a result, their plural inflection is automatically produced by the default.

All in all, the results of this study are quite revealing with regard to the nature of the default inflection of Hebrew nouns, and the status of plural suffixes as defaults; they are less instructive about the role of the roots. The observation made here does not question the “words and rules” theory. It only suggests that in the context of noun inflection, the base, as an amalgam of the root and the vocalic pattern, and not the root by itself, dictates how the noun as a whole is inflected. In the terminology of “words and rules” (Pinker, 1999), the base, not the root, should be considered the variable (symbol) that is involved in inflection.

In a second study, Berent et al. (2002a) replicated the 1999 study with a refined procedure. This study focused on a distinction known as the “faithfulness” of the word’s stem to the word’s base. Recall that the word’s base is the word we normally find in a dictionary, or the unaffixed and uninflected word (e.g., *delet* ‘door’). The stem is the base as changed in the process of inflection (e.g., *dlat-ot* ‘doors’). This change, most often in the vocal pattern, occurs in Hebrew words, as it does in the words of some Indo-European languages.

Thus regarding the inflection of Hebrew nouns, one should consider two independent parameters: affixation and stem change. When inflection does

not involve a stem change, we may speak of the stem's faithfulness to the base; when it does, it is considered "unfaithful." In Berent et al. (2002) the participants in the first two experiments were presented again with nonwords that were similar to a different degree to either regular or irregular Hebrew masculine nouns. In Experiment 1 the inflected word patterns were always unfaithful to the base. Inflecting such targets systematically changes the base. In contrast, the patterns used in Experiment 2 were invariably faithful to the base. It was predicted that a regular suffix, inflected by a default procedure, would be applied regardless of whether the inflected form was phonologically faithful, or similar, to an existing regular plural. Irregular nonwords, inflected by analogy to an irregular masculine noun, would presumably be affected by similarity to nouns in memory. The results confirmed this prediction: Despite the phonological unfaithfulness, regular and irregular targets were indeed differently affected by similarity to existing nouns. As in the 1999 study, irregular analogous nonwords proved more sensitive to similarity.

In summary, the results of this study converged with those of the 1999 study in showing that unlike the inflection of irregular nouns, the default plural inflection of Hebrew masculine nouns—the inflection operated by the linguistic rule—does not depend on analogies to similar regular nouns. In addition, this particular study indicates that this conclusion holds true whether or not the regular plural forms preserve the stem faithful to the base word.

In general, it is suggested, complex (inflected) words should not be dichotomized into "regular" or "irregular." Different aspects of words may be regular or irregular, depending on whether or not they are applied by a rule. A word can be affixed irregularly but remain phonologically faithful to the base, and vice versa. Phonological faithfulness, so it seems, is of secondary importance in a decision to form the plural in a regular or irregular manner. In other words, the default procedure in Hebrew can tolerate stem change. This result is somewhat challenged by Vaknin's study, reported in the following.

The Mechanism of Regular and Irregular Inflections

The studies reviewed so far did not directly confront a number of questions central to an understanding of morphological processing such as inflections in Hebrew. First, how are regular and irregular noun inflections stored in the Hebrew mental lexicon? Second, do regular and irregular inflections make different demands on the Hebrew speaker's cognitive system? To deal with these issues we have to consider the mechanism of inflecting regular and irregular nouns and the nature of the storage of lexical and sublexical elements in the mental lexicon.

Berent, Pinker, and Shimron (2002, p. 460) suggested that regular inflection, which is achieved by a rule, is applied by default on the failure to find a

stored irregular inflection in the memory. This suggestion implies that regular inflections are executed in two steps. First, the memory storage of irregular inflections is searched, and if the search comes up with no results, regular inflection by default is activated. It follows that regular word inflection, performed after a memory search, must take longer than the inflection of irregular words. The approach that justifies such a model, it seems, assumes that regular inflections are not stored in the mental lexicon; and cognitive processing is linear, as opposed to parallel. Accordingly, the mental lexicon contains only irregular inflections together with all regular singular forms, and a small number of affixes. It is then not too cumbersome to inflect the majority of the words by searching a relatively short list of irregulars first, and then, in the case of regular words, when the search terminates with no results, to activate the default procedure. This approach assumes that our memory for plural forms contains just irregulars, because otherwise, even regular words could be inflected through the memory search.

However, as Pinker (1999) pointed out, according to such a model the slowest irregular inflection should be executed faster than the fastest regular inflection—a prediction evidently wrong, as demonstrated by studies showing that irregulars are inflected more slowly (e.g., Prasada, Pinker, & Snyder, 1990; cf. Vaknin, 2000, 2004). Instead, as Pinker suggested, a parallel processing of regular and irregular inflection exists: simultaneously looking up the word in memory and activating a linguistic rule. If the word is irregular, he said, what is stored in memory inhibits the activation of the rule, slows it down, and eventually, turns it off. “[N]o verb,” Pinker argued, “is either regular or irregular until it has been looked up in memory and discovered to have or to lack, a special [past-tense] form” (p. 131).

The operational implications of Pinker’s (1999) model, as I understand them, are: (a) the slow inflection of irregular nouns results from conflicting information emerging from the memory search on the one hand, and the activation of the default on the other; (b) when conflicting information surfaces, one source of information must be discarded or blocked; (c) taking into account that fluent speakers rarely err in plural inflection, the information that is blocked is always the output of the default, not the results of the search in the memory; and (d) blocking takes a cognitive effort, and is therefore time consuming.

Because linguistic operations are performed as manipulations of the morphological elements stored in the mental lexicon, a model of the inflection mechanism must also specify these stored items. There is no question about irregular inflections—they must be stored in the mental lexicon as whole words, and retrieving them is the only way to inflect correctly. But what about the regular inflections? According to one view of phonology formulated already by Bloomfield (1933) and later by Chomsky and Halle (1968), regular inflections—those produced by a default—are not stored in the men-

tal lexicon. Pinker (1999) and Pinker and Prince (1991), although insisting, like Berent et al. (1999, 2002a) that regular inflections are generated by a rule, left open the issue of whether or not regular inflections are also stored in the memory. As Pinker (1999) put it:

[M]emory is constantly working alongside rules—that's how irregular verbs arise to begin with—and it would be a strange mental block indeed that would force the memory system to be amnesic for all the regular past tense forms it hears. . . The words-and-rules theory predicts only that people don't *depend* on stored past tense forms, not that they are *incapable* of storing them. (p. 137; italics in the original)

According to Pinker then, people are capable of storing regular inflections, but whether they indeed store all regular inflections in their mental lexicon, just like they do with irregulars, remains unclear.

With regard to derivations, Jackendoff (1975) argued that all derived words are listed in the lexicon; because they display so many formal and semantic irregularities, their description by means of rules becomes highly impractical. In conjunction with such an assertion, Booij (1993) stated that plural inflection of nouns is more akin to derivation than to inflection, because pluralization changes the meaning of a noun; in this sense, plural inflection is similar to many derivational word formation processes. If Booij is right, all plural forms are probably also stored in the lexicon.

Also, if, as Pinker said, "memory is constantly working alongside rules," it seems reasonable that the memory search for a plural inflection is just as automatic as inflection by the rule. If so, and if regular inflections are also stored in memory, it seems hardly possible that the automatic search will be confined to irregular inflections.

However, if this conclusion is valid the interpretation of Berent et al. (1999, 2002a) should be reconsidered. Berent et al. found that irregular but not regular inflections are sensitive to similarity effect (see above). The difference, it was suggested, derived from the difference in the processes by which regular and irregular words are inflected. Unlike regular words that are inflected by a morphological default, irregular words are inflected via a memory search, and a memory search is more sensitive to similarity. However, once it is accepted that the inflection of regular words involves the same memory search as that of irregulars, this interpretation seems inadequate. An alternative model of the mechanism of inflection is proposed below.

The Nature of the Default Inflection

Another research project dealing with Hebrew noun inflection was conducted by Vaknin (2000, 2004; Vaknin & Shimron, 2003). This study starts with the conclusion suggested by Pinker (1999) just stated, so it is assumed

that the search in the mental lexicon occurs simultaneously with activation of the default procedure, in inflecting all nouns, regular and irregular. When the output of the default is evoked, it can be immediately checked against the lexicon search. Therefore, in line with Pinker (1999), it is hypothesized that irregular nouns are inflected more slowly because the default procedure and the memory search yield conflicting results, and a selection decision or an inhibition of the default output is required. The question asked in Vaknin's study concerns the implications of the activation of the default procedure in inflecting Hebrew nouns, taking into account the large number of items that are inflected irregularly.

In her empirical work, Vaknin (2000, 2004) set out to examine the actual duration of inflections. She asked whether regular and irregular plural inflections in Hebrew nouns are processed differently. As noted, if a default procedure is automatically executed, irregular nouns are expected to be inflected more slowly as the automatic activation of the default inflection by the regular suffix conflicts with the outcome of the lexicon search and must be blocked or rejected.

In an attempt to examine this prediction, Vaknin (2000, 2004) asked adult Hebrew speakers to inflect online regular and irregular singular nouns, masculine and feminine. She hypothesized that if plural inflection is done by association only, regular and irregular nouns should be inflected alike, provided their frequency is held constant. If, on the other hand, two inflection procedures are taking place, one by suffixation via a default procedure and the other by activation of singular-to-plural links in the mental lexicon, a relatively fast inflection of regular nouns and a relatively slow inflection of irregular nouns should be expected.

Vaknin's participants were presented with lists of nouns having regular and irregular plural forms. The experimental design was naming plus inflection, that is, they performed an online plural inflection in a naming task. The participants were presented with regular or irregular singular nouns and were asked to name (articulate) their plural form. The latency of their responses and the number of errors made were recorded.

Vaknin's (2000) results indicate that irregular nouns were indeed inflected more slowly than regular nouns, and their inflection involved more errors, even when frequency was held constant. It was also found true with very frequent nouns. Vaknin interpreted the differences between the inflection of regular and irregular nouns as supporting a dual-route model. By one route a morphological default procedure is executed, and by the other a search in the mental lexicon is performed. In the inflection of regular nouns, the outputs of the two routes are identical. In fact they reinforce each other, and the process as a whole is relatively fast and almost error-free. In the inflection of irregular nouns the outputs of the two routes are in conflict, so

the results from operating the default procedure must be blocked or rejected in favor of the results derived from the search in the mental lexicon.

Based on these results, Vaknin (2000; Vaknin & Shimron, 2004) suggested that a default procedure is operative even in a situation where gender and number inflection are only partially productive, as is the case with Hebrew nouns. Apparently, despite the low productivity of plural inflection of Hebrew nouns, if a large enough group of nouns are inflected in a certain way, speakers adopt an automatic default procedure. But owing to imperfect or low productivity, the default procedure when applied to irregular nouns taxes plural inflection in a large number of cases.

Vaknin's study converges with the studies of Berent et al. (1999, 2002a) in demonstrating that affixes, at least those used in pluralization, are stored in the mental lexicon, together with bases and stems.

More evidence on the operation of a default procedure is provided in observations of spontaneous inflections of new and unfamiliar words. These may be imported foreign words or words arising through "educated errors" made by children at various stages of language acquisition (e.g., **goed*).

The Effect of Stem Change in Noun Inflection

Vaknin (2004) extended her first study by systematic investigation of the effect of stem change (in the form of vowel alteration: see above) in regular and irregular inflections. In one of her experiments, Vaknin again asked her participants to inflect Hebrew nouns online. The participants were given a list of singular nouns and were asked to articulate their plural forms as fast as possible. The time from the onset of the singular form to the beginning of articulation, and the number of errors made, were recorded. Of the entire list of nouns, half were regular and half irregular; in each of these groups, half were masculine nouns and half feminine. In addition, the nouns had various degrees of vowel changes in their stems. Some had zero change (e.g., *šir*—*šir-im* 'song-songs', *bama*—*bam-ot* 'stage-stages', *šana*—*šan-im* 'year-years'). Others had one vowel change, for example, *gamal*—*gmāl-im* 'camel-camels', *matar*—*mtar-ot* 'shower-showers'; and still others had two vowel changes, for example, *devek*—*dvakim* 'glue-glues', *erec*—*arac-ot* 'land-lands'.

The overall results showed again that irregular nouns were inflected more slowly than regular nouns. More importantly, the difference between zero vowel change and one vowel change proved significant. Nouns with no vowel change were inflected faster than nouns with one vowel change, but the difference between one vowel change and two was not significant. In analyzing stem change in regular and irregular nouns, Vaknin found an interaction between regularity and vowel alterations. In regular forms the overall pattern of results was found statistically significant; nouns with no vowel

change were inflected faster than nouns with one vowel change, but the difference between one vowel change and two was not significant. However, with irregular nouns, stem changes did not affect pluralization.

Vaknin (2004) concluded that if the noun is irregular due to affixation, another facet of irregularity in the form of a stem (vowel) change is tolerated or at least does not demand additional effort in processing plural inflection. But if the noun is regular, a stem change alone is apparently enough to entail more effort in plural inflection, although the number of phonological changes makes no additional difference.

It therefore appears that irregular nouns, inflected through memory search, are not affected by stem changes. Once a link between a singular irregular noun and its plural form is established, the speaker is reminded of all possible idiosyncratic features of the plural form, including stem change. The number of these features makes no additional difference. However, if the noun is regular, a stem change interrupts the default procedure of simple stem-plus-suffix concatenation and results in slower inflection.

The results of Vaknin (2004) are not consistent with those of Berent et al. (1999, 2002). Vaknin's participants showed sensitivity to stem changes in inflecting regular nouns. However, these two studies should be compared with much caution as the tasks in them were completely different. More research is needed in this domain.

* * *

How does the empirical evidence reviewed in this chapter square with the decomposition hypothesis? Speakers of Hebrew are evidently sensitive to the morphological structure of the words, and may engage in some sort of decomposition. They may also be said to have direct access to whole words, including inflected words, and to affixes. A reasonable inventory of sublexical elements in the Hebrew mental lexicon cannot be offered yet with any certainty, because the empirical evidence gathered so far is limited. What seems most intriguing in light of the recent linguistic analyses discussed earlier is how sensitive, if at all, Hebrew speakers are to the sublexical elements assumed by linguists to be central to morphological processing in Semitic languages—the base and stem. This question, again, awaits further research.

The Power of Roots: Semantic or Morphological

The findings of two groups of researchers, Frost, Deutsch, Forster, and their associates, and Berent, Shimron, and their associates, support the view that the Hebrew root is an independent structural entity. But because root gemination restrictions have nothing to do with meaning, and masked priming may not allow complete word comprehension, owing to the very short pre-

sensation of the prime, the question regarding the power of roots beyond their role in the perception of Hebrew words is still open in view of the research that can be presently reported.

However, a few studies do provide information about the role of roots, considering more than the root's perceptual processes (e.g., Bentin & Feldman, 1990; Frost et al., 2000b). As mentioned earlier, Bentin and Feldman (1990) found no semantic effect in Hebrew in simple repetition priming after a long lag. But in studies investigating a priming effect after a short lag, a semantic effect was found in some experimental settings but not in others. For example, Bentin and Feldman found a semantic priming effect with roots after a short lag; Feldman and Raveh (2003) reported a significant semantic priming effect with Hebrew roots in verbal inflections and derivations.

The question is how to explain the incompatible findings from word recognition studies. In a series of studies conducted in English, Feldman and her associates found that the time interval between the presentation of the prime and the target dramatically influenced the results. With exposure to a very short prime duration, a semantic effect did not surface. Possibly, the authors suggested, when prime visibility is relatively limited, and time to process the prime is restricted, there is no effect of semantic priming. Such a conclusion is consistent with the observations reported by Deutsch and colleagues (1998). Based on their review of studies involving a variety of priming techniques, Feldman and Raveh thus concluded that there is no evidence that semantic priming is determined by language-specific factors. More likely, it depends on the particular experimental setting of the priming procedure.

SUMMARY

Resolving the Differences Between Proponents and Opponents of the Root-Based Approach

As we saw in the first part of this chapter, some linguists argue against the traditional root-based approach to Semitic languages, and prefer a word- or a stem-based approach; but the experimental data support the notion that roots and patterns have an independent status in our mental lexicon. The observations of linguists presented earlier in this chapter in a sense reject the role of roots and patterns as the elements that govern the linguistic behavior of Semitic-language speakers. How may this disparity be explained?

I suggest that the two parties may not be focusing on the same facets of linguistic processing. Linguists are interested in examining the variety of mechanisms of word formation along the lines of the input-output principles of generative morphology. Most psycholinguists, intrigued by the possibility of word decomposition as part of the general process of word comprehension,

investigate speakers' sensitivity to sublexical elements. In the research on Semitic words, the morphological elements investigated so far were the root, the pattern, and the inflectional affixes. The concerns of the two groups of scientists are somewhat different. One may be sensitive to (or aware of) the presence of certain linguistic entities. Yet this sensitivity or awareness may or may not dictate one's linguistic behavior. Generally, psycholinguists find that (a) speakers of Semitic languages internalize implicit knowledge of the morphological structure of their language, and (b) under the conditions and requirements of a specific task in the laboratory they actually demonstrate their sensitivity to the appearance of certain subword elements (morphemes and/or other orthographic patterns).

This in itself does not mean that in all other conditions, and for all other purposes, linguistic operations in Hebrew will be governed by these units. Hebrew speakers are apparently free to choose the level (or the depth) of decomposition as their input for word formation, namely whole words, stems, roots, patterns, and affixes. What linguists show us is that for some purposes, and in some conditions, speakers of Semitic languages may manipulate an array of linguistic elements that go beyond their knowledge of or sensitivity to roots, patterns, and affixes. The cumulative evidence obtained from the psycholinguistic data is that the root and the pattern prime the whole word, and the pattern by itself, even when accompanied by a nonroot, delays a lexical decision. Hebrew speakers are sensitive to the internal characteristics of the roots, as demonstrated by the manipulation of consonant gemination; and finally, children from a very early age can successfully demonstrate their knowledge of legitimate pattern structures such as *mishkalim* and *binyanim*, and are able to produce new words while obeying morphophonemic rules.

All this clearly implies that roots and patterns probably exist as special entities in the mental lexicon of the Hebrew speakers examined in these studies. Yet none of this evidence precludes the possibility that other parts of Hebrew words, linguistic entities that are perhaps larger than or different from roots and patterns, may have their own independent status in the mental lexicon or may affect linguistic behavior. Bases and stems may be particularly important. In Hebrew many bases are words in their own right, but they may also be an input for producing other words. As noted, when the vowels are stripped from the base or the stem we normally get the bare root. Then, by transforming the vocalic patterns, and/or affixing the stem in different ways, or, put otherwise, by inserting the root in a different pattern, we arrive at the central mechanism of Hebrew (Semitic) word formation.

Yet bases and stems ought to be seen as independent morphological elements, alongside roots and patterns, as well as a variety of affixes. The process of word recognition, when involving word decomposition, may get sometimes at the base or stem level; at other times it may go deeper, to the root and pattern level. A word decomposition process may also be executed by

stripping affixes from the stem. In addition, the evidence attesting that speakers of Semitic languages are sensitive to roots and patterns does not mean that such sensitivity has a part to play in every linguistic process and does not preclude sensitivities to other types of morphological entities.

This suggestion differs from the model proposed by Deutsch and Frost (2003). They envisaged a dual-route model for morphological processing of Hebrew words. One route is used for the search or activation of whole words, and the other leads to the extraction of the root and/or the word pattern. In view of the variety of the linguistic data mentioned here, I find Deutsch and Frost's model, which takes into account only words, roots, and patterns, too restrictive. I suggest a more versatile model of word decomposition to account for the multiple sorts of data uncovered by linguists and psycholinguists. In such a model all kinds of sublexical units coexist. In Semitic languages these are words, patterns, stems, roots, and affixes. When recognized, they are automatically processed until the word as a whole or an assemblage of its units affords word recognition. In processes of word formation, several units, combined with other units or not, may be used to form new words according to some predefined assembly rules. At this point we cannot be certain, because research on this issue has only just started and most of it focuses on the root and the pattern only. It should be interesting in future research to investigate the factors that affect the depth of analytic linguistic activity.

In addition, in the attempt to narrow the gap between the conclusions of linguists and psycholinguists, we should note that some linguists examine processes of formation of very special types of words—often borrowed (loan) words. They have indeed found that speakers are affected by features of the source words, sometimes at the expense of obeying the general structural rules of Semitic inflections and conjugations. Nevertheless, it may not be excessive to suggest that violations such as these are to be found in every natural language. They do not necessarily rule out general principles of syntax or morphology. Chomsky and Halle (1968) once remarked that “we must design our linguistic theory in such a way that the existence of exceptions does not prevent the systematic formulations of those regularities that remain” (p. 172). This suggestion may put some of the evidence brought by linguists in the right proportion.

5

The Development of the Hebrew Language

The Semitic Origin

Let me start with what I mean by “Semitic” in this context. What is often referred to as the “family of Semitic languages,” or, more correctly, the Hamito-Semitic family, is not easy to define. Philologists can tell us who the members of the family are (and were) by pointing out common threads in the languages in question. But they are less certain about the parents or whether parents ever actually existed at the start of the family tree from which various languages and dialects later evolved. Rabin (1999) suggested that the common threads in Semitic languages were developed in regions where these languages were spoken, and that the notion of branches that preceded the languages themselves is somewhat mistaken. Even researchers who trace the genesis of Semitic languages to a single source admit, as Faber (1997) stated, that “In particular cases, it may be difficult—if not impossible—to determine whether a particular similarity between two Semitic languages results from their shared ancestry or from subsequent contact” (pp. 3–4). Such a subsequent contact might have been of various kinds—political, cultural, economic, commercial, and many others. We know of major influences such as Akkadian, Amorite, and Hamitic on Semitic languages spoken far beyond their regions. Interestingly, both Rabin and Faber, who cautioned against genetic speculations, continued to use the term Proto-Semitic in postulating an ancient parent of Semitic languages. I am not in a position to settle this issue, so my discussion is limited to the geographic perimeters of the spoken Semitic languages, past and present, listing the groups of languages in different regions of the “Semitic space.” I also briefly mention aspects of similarity in Semitic languages.

The ancient Semitic space extends from Sudan, Ethiopia, and Saudi Arabia in the south to what is today Syria, Iran, and Iraq in the north and east. Semitic-speaking populations also exist in the Mediterranean (e.g., Malta) and along the northern coast of Africa (e.g., Morocco, Tunis, and Algeria). Evidently, at all times the Semitic space was a much larger area than the traditional "Fertile Crescent."

The classification of historical Semitic languages according to their regions is as follows. The northeast area included Akkadian and Assyrian. The northwest embraced Amorite, Eblaite, Ugaritic, Canaanite, Phoenician, Hebrew, Moabite, Amonite, Edomite, Aramaic, Nabatean, Syriac, and Mandaic. The southern region had and still has Arabic and a number of Ethiopian languages: Ge'ez, Tigre, and Tigrinya in northern Ethiopia; Amharic, Harary, and Gurage in southern Ethiopia. In central Ethiopia there are also Chaha and Gura, among others.

Most Semitic languages are no longer spoken. The largest population of contemporary speakers of Semitic languages speaks Arabic in its various dialects. Several Ethiopian languages, most notably Amharic, are also in wide use, and so is Hebrew, primarily in Israel. Aramaic (or rather Neo-Aramaic) is still spoken in different areas, and Maltese, an Arabic dialect strongly influenced by Italian, is spoken on the island of Malta. Some Semitic languages such as Neo-Aramaic, Mandaic, and Syriac, have survived because they served as vehicles of sacred scriptures. Sacred scriptures were also instrumental in the preservation of Hebrew and Classical Arabic. Hebrew ceased to be a spoken language for almost 2,000 years, but it was continuously used and developed in written communication, and of course reading, for a variety of purposes.

Common threads among various Semitic languages are related to each and every linguistic characteristic, namely phonology (consonants and vowels), morphology (the ways morphemes are combined in complex words), the lexicon, and perhaps some facets of the syntax.

Semitic Characteristics. The most distinctive and common feature of Semitic languages is that many words have roots consisting of (generally three) consonant letters. As is described in chapter 2 on the Hebrew word, for the most part, the three consonantal roots carry certain core meanings whereas vowels (and affixes where applicable) play the role of modifiers, indicating grammatical and some semantic specifications. For English speakers, an analogous demonstration of this characteristic (Kutscher, 1982) is the comparison of the words SING, SONG, and SUNG on the one hand, with LIVE, LOVE, and LEAVE on the other. The first triplet is one of the exceptional cases in which English resembles the Semitic principle. If we take SNG as the root of these words, we may define a core meaning for these words, namely having something to do with singing, and then identify the vowels as

qualifiers or specifiers of the exact meaning of each word. The words of the other triplet, LIVE, LOVE, and LEAVE, do not have a common meaning. The fact that they share the same consonants is sheer coincidence. Consequently, they cannot be said to possess a common root as in a Semitic language.

Given that the Semitic root generally has a core meaning and its phonological pattern indicates grammatical specifications, the inevitable question arises with regard to the system's productivity. Linguistic elements such as roots and patterns are productive to the extent that they can be repeatedly used to produce instances of the same type (in this case, Hebrew words or word bases). The question then is, How lawful and predictable is the derivation of words from roots and patterns? I elaborate on this issue in chapter 2.

An important characteristic of the Semitic word structure is that the root and the pattern, as two bound morphemes (morphemes that cannot occur as separate words), are not combined linearly, one after the other, as is generally the case in non-Semitic languages, but the root is interwoven into the word pattern. For example, in the word *rakevet* 'train' the three consonants of the root R-K-V are inserted into the pattern is CaCeC-et, where capital Cs stand for the root consonants. Other roots may be inserted in this same pattern to form other words, e.g., *zameret* '(female) singer' from the root Z-M-R.

Other shared features of Semitic languages are manifested in their common vocabulary, that is, having roots bearing the same meaning in different Semitic languages. For example, the word 'brother' sounds as 'ax in Hebrew, and also in Ugaritic, as 'axa in Aramaic, 'axum in Akkadian, 'axun in Arabic, and 'exw in Ge'ez (old Ethiopic). There are also similar forms or general principles of inflections and derivations, best observed in reference to *binyanim* and *mishkalim* (see below) that are common to Semitic languages.

Another characteristic of Semitic languages is their sensitivity to root consonant co-occurrences (Greenberg, 1950). In a typical triconsonantal root, the number of roots that start and end with the same consonant letter is extremely small. Š-R-Š, and K-R-K 'city' are among the exceptions. Other possible co-occurrences are known as gemination, namely, the duplicating of a consonant letter so that they appear twice in a row. As we are largely speaking about triconsonantal roots, gemination may be manifested as either the first two or the last two consonants being duplicated. It has been noted that although final gemination, for example, D-M-M 'bleed' or B-D-D 'alone' or XGG 'celebrate' is quite frequent, initial gemination is rare. M-M-Š 'concrete' and M-M-N 'finance' are among the exceptions (cf. McCarthy, 1986, and chapters 2 and 4).

Regardless of this phenomenon, it was noticed that a group of very basic words, many of them connoting body parts tend to be biconsonantal (Blau,

1972; Kutscher, 1982). Examples in Hebrew are *yad* 'hand', *shad* 'breast', *dad* 'nipple', *kaf* 'palm', *roš* 'head', and *dam* 'blood'. Other basic words based on biconsonantal roots are *yom* 'day', *šana* 'year', *tov* 'good', *ra* 'bad'. The two-consonantal words do not necessarily derive from two-consonantal roots. Some were imported into Hebrew as whole words, not by way of derivation from existing roots.

However, some roots are believed to have been originally biconsonantal, but later expanded to suit the more typical Hebrew word structure, which has triconsonantal roots, by doubling the second consonant, thus forming roots such as B-D-D 'alone', C-F-F 'crowd', Š-R-R 'poetized', X-B-B 'like', and many others. This view is supported by the fact that many of these roots may be found in constructions that still employ both the original biconsonantal root and the later developed triconsonantal root. The two types continue to share the same core meaning, for example, *šorer* and *šar* mean to sing, and *xiba* and *xovev* (/v/ replaces /b/ in some word contexts) have to do with liking.

THE HISTORY OF HEBREW

Because of space limits, this review is rather short. For comprehensive discussions of the history of Hebrew, the reader is referred primarily to the volumes of Kutscher (1982) and Rabin (1973, 1999), and also to Sáenz-Badillos (1993). A comprehensive discussion of Biblical grammar is offered by Blau (1976) and brief chapters by Polotsky (1964) and Steiner (1997). An extensive discussion of Mishnaic Hebrew (in the Hebrew language) is provided by Ben-David (1967, 1971). For discussions of Medieval Hebrew in the English language, the reader is referred to Baron (1958) and Pagis (1991). Hebrew readers may consult Schirmann (1954, 1995) and Pagis (1976). For discussions of contemporary Hebrew the reader is referred to Berman (1978), Nir (1989), Rosén (1977), and Schwarzwald (2001). For concise summaries of the history of Hebrew, see Berman (1997b, 2003), Hetzron (1987), and appropriate articles in the Hebrew Encyclopedia (Vol. 26, "*Ivrit, Lashon*") and Encyclopaedia Judaica (Vol. 16, "*Hebrew Language*").

In the course of its approximately three and a half millennia of existence, the Hebrew language has maintained remarkable stability, attested by the fact that texts from the past are fairly accessible to present-day Hebrew readers. Nevertheless, the inevitable interaction with several ancient cultures (Amorite, Aramean, Persian, Greek, Roman, and Arab) and more contemporary ones, and as a result of socioeconomic conditions dictated by life in exile, the Hebrew language underwent significant modifications and expansions.

The history of the Hebrew language may be divided into several periods: pre-Biblical, Biblical, the Dead Sea Scrolls era, Mishnaic, Medieval, and Modern. In neither the Pre-Biblical nor the Biblical era was the term “Hebrew language” used. The Bible speaks about the language of Canaan (Isa. 19:18) or the “Judean” language (II Kings 18:26, Isa. 36:11, 13, Neh. 13:24), a language spoken by inhabitants of Canaan or Jews. The Jews who entered and settled in Canaan probably adopted the local language, abandoning that of their forefathers who, according to the Bible story, came from Mesopotamia and spoke one of the local languages common there.

Pre-Biblical Hebrew

Apparently Hebrew was not a distinct language in the pre-Biblical era. Some researchers believe that in its earliest phase, the family of Semitic languages along the eastern shore of the Mediterranean and farther south into Arabia and Ethiopia was “one single tongue spoken by a compact society in a geographically continuous area” (Polotsky, 1964, p. 108). The common name for this tongue is Semitic. The later evolution of related but distinct languages (or dialects), of which Hebrew was one, is conceived as the result of the dissolution of Semitic unity along geographical and ethnic lines.

Our knowledge of the Hebrew of pre-Biblical times comes partially from texts written in the region that mention Canaanite people, places, or expressions. Such texts were generally written in Akkadian or Egyptian scripts, none of which was capable of a complete and reliable transcription of Canaanite words. Thus, one must be very cautious with these data.

An important Egyptian source is the Execration texts (Sethe, 1926; Posener, 1966). These are inscribed on vases containing the names of potential rivals. The authors of these texts believed that smashing the vases would destroy rivals whose names were written on them. The texts are from the 20th and 19th centuries BCE, and among them are some Canaanite names. Another Egyptian source contains lists of slaves, some with Hebrew names (Albright, 1954). Also, Akkadian texts found in Ur and Babylon contain several names of Canaanite origin (Huffman, 1965).

The most important Egyptian source of Canaanite (or Hebrew) words is a collection of letters found in El-Amarna, Egypt. The letters were written in Akkadian and date from the 14th century BCE. They contain correspondence between the ruling Egyptians of the time and their vassals in Canaan. Fortunately for us, the Canaanite scribes were not fully conversant in Akkadian and thus often replaced Akkadian words and expressions with local ones (Albright, 1954). Occasionally, perhaps because they were unsure of the right Akkadian word, the scribes would write Canaanite words in the margins. The local parts of the El-Amarna letters consist of words and forms

that share features with Hebrew and Phoenician, but with no other language (Rabin, 1973).

Finally, six letters found in Ta'anach (located in present-day central Israel) are believed to have been written as early as the 16th or 15th century BCE by local scribes in Akkadian, using alphabetic cuneiform.

The data from these sources are limited in scope, but they do provide some important information about Canaanite, pre-Hebrew phonology, syntax, and morphology. A significant feature of the pre-Hebrew languages of those times was that, unlike Biblical Hebrew, where case endings began to diminish, pre-Biblical morphology still had a few: nominative (marking the sentence noun or noun phrase when it is the subject of a verb), accusative (a noun or a pronoun marking the verb object), and genitive (marking a possessive relationship). These three cases were distinguished by the suffixes *-u*, *-a*, and *-i*, respectively (in the singular forms). One case that still exists is the directive *-a*, for example, *yamin-a* 'to the right'. Also evident in pre-Biblical sources are verbs already structured in *binyan* (conjugation pattern; pl. *binyanim*). The tense system in pre-Biblical texts prefigured the Biblical tense system in that, unlike Modern Hebrew, it marked aspect rather than tense such as past, present, and future. Aspects denote the status of an action as being completed (perfect) or continuous. The mark for the perfect tense was the prefix *va-* as in *vayomer*, meaning "he has said." This and other forms of aspects continued to feature in Biblical Hebrew alongside new forms of marking tense.

Biblical Hebrew

The principal source of Biblical Hebrew is, of course, the Bible itself. But we should not assume that the Biblical text is an accurate reflection of the language spoken by the Jews at that time. There are about 8,000 different words (each meriting a separate entry in the dictionary) in the Bible; yet it is estimated that the entire Hebrew vocabulary in Biblical times consisted of as many as 30,000 words (Rabin, 1973). The Bible, of course, is not an encyclopedia, and its texts do not relate to all domains of life. The post-Biblical scripts written in Israel, such as the Mishna and the Talmud, where writers' concerns encompassed a wide variety of topics, include many more thousands of Hebrew words. So it is safe to assume that many of these words were already used much earlier, namely during the Biblical era.

Non-Biblical texts from which we can learn about the Hebrew of this time include the Gezer Calendar (10th century BCE), an ostrakon from Shechem (Nablus) (c. 8th century BCE), the Siloam inscription, inside an aqueduct leading to Jerusalem (700 BCE), and a group of letters from Lachish and Arad (6th century BCE). More information about Biblical Hebrew derives from Akkadian, Greek, and Latin transcriptions. Some of these sources are

of particular importance because Biblical texts themselves were not fully voweled until the 8th century CE, about a thousand years after Hebrew ceased to be a spoken language.

Interestingly, considering the Biblical story of the Jews living in Egypt for almost 200 years, one would have expected an Egyptian influence on Biblical Hebrew. After all, the Egyptian civilization was highly developed. However, Biblical Hebrew contains very few Egyptian words (about 40) and even these are mostly names of Egyptian institutions or trade terms (Rabin, 1973). One way to explain this dearth is by assuming that the Semitic civilization found by the Israelites in Canaan and neighboring areas (e.g., Phoenicia, Ugarit) was itself highly developed—prolific enough to provide the literary means for the texts that comprise the earlier books of the Bible. Our impression of great civilizations is largely made by their monumental remnants (e.g., Egypt, Assyria, Greece, Rome), and these were practically nonexistent in pre-Biblical Canaan. However, the testimony of a literate civilization does not necessarily reside in limestone and bronze. Sometimes texts (written or not) are greater than monuments.

As may be expected of a language spoken for a period of about eleven hundred years (12th to 1st century BCE), Biblical Hebrew underwent several stages of development. A group of poems, those attributed to Jacob (Gen. 49), Balaam (Num. 24-25), Moses (Ex. 15; Deut. 33), Deborah (Jud. 5), and Hana (I Sam. 2:1-10), are believed to reflect the early Biblical language of the First Temple, sometimes called “Archaic Biblical Hebrew” (Kutscher, 1982). The song attributed to Deborah (Jud. 5), dated from the 12th century BCE (Ginsberg, 1970), is believed to be the earliest Biblical text. Most Biblical prose is defined as “Standard Biblical Hebrew.” This is the Hebrew of the First Temple and the first exile (about 1000 to 500 BCE). The Hebrew of Chronicles and several later books is considered “Late Biblical Hebrew” or the Hebrew of the Second Temple (about 500 to 150 BCE), when Hebrew was gradually replaced by Aramaic as a spoken language yet continued to be used in reading and writing. Some researchers believe that Aramaic was spoken in the north, whereas Hebrew continued to be spoken in Judea (Rabin, 1973).

Unlike the meager legacy of the pre-Biblical, Canaanite language, the Bible offers a large variety of literary forms—prose, poetry, speeches, fables, proverbs, prophecies, blessings, curses, and many more. In reference to Biblical prose, it seems clear that the verb system can no longer be said to mark only aspects. In addition, past and future forms are clearly distinguished. Moreover, forms of the present tense reflect both the participle and simple present tense, although strictly speaking the present tense was not developed. The aforementioned *binyanim* ‘buildings, constructions’ of Biblical Hebrew are basically the same as those of Modern Hebrew (see chapter 2).

The Dead Sea Scrolls

The texts found in the Judean Desert reveal a version of the Hebrew language that may be considered a link between Biblical and Mishnaic Hebrew. They contain elements of Biblical form as well as Aramaic and Mishnaic Hebrew. The most prominent texts are copies of Bible books, closely similar but not identical to the Masoretic text (the canonic edition of the Hebrew Bible, known in the Christian world as the Old Testament, compiled in Tiberias in the 8th century). In the Isaiah scroll, for example, one can see an increase in the use of vowel letters, known as *matres lectionis*, ‘mothers of reading’ (Hebrew *’imot kni’ah*). These are letters with a dual function; originally used to present only consonants, but later assigned a second role, to represent vowel phonemes (see chapter 3). In some of the other texts rather archaic word forms appear (e.g., genitive, case markers) conceivably because of an Aramaic influence.

Mishnaic Hebrew

Mishnaic Hebrew was the language spoken in Judea from at least the destruction of Jerusalem and the Second Temple (70–73 CE) until the interim period between the canonization of the Mishna (200 CE) and the beginning of the compilation of the Talmud. Hebrew ceased to be a spoken language for several centuries. The Mishnaic Hebrew was spoken up to the 2nd century CE, but continued to be instrumental in writing for many years to come.

It is widely believed that Mishnaic Hebrew was in fact a spoken language for some centuries before the destruction of the Second Temple, concurrently with Aramaic (Kutscher, 1982; Rabin, 1973). It may have been commonly used in a colloquial (spoken) version of Biblical Hebrew. If this is the case, the appearance of the Mishna, with its mature crystallized style, seems to have evolved out of the decision forced on the *Tana’im* (sages who compiled the Mishna) to use the vernacular for writing the Mishna, the Midrashim, and other texts. Apparently, the pupils of the *Tana’im* were no longer fluent in Biblical Hebrew, and their teachers were unwilling to use Aramaic for deliberations on Biblical questions and rulings. Rabin (1973) suggested that the *Tana’im* of the Pharisee sect were close to the common people and taught them the law in public lectures. “As their instruction was oral, they used the spoken language even when, in the end, they wrote down their teaching” (p. 39).

The main sources of Mishnaic Hebrew, in addition to the books of the Mishna itself, are a group of books called *Midrashim* (sing. *Midrash*), the *Tosefta*, *Baraytot* (sing. *Barayta*), and many more. As noted earlier, some of the texts found in the Judean Desert (e.g., the letters of Bar-Koseba [Bar-Kokhba]) were written in Mishnaic Hebrew.

Mishnaic Hebrew is considerably different from Biblical Hebrew. Some of its distinctiveness results from the influence of Aramaic and Greek, languages commonly used by Jews at that time for both reading and writing. Compared with pre-Biblical and Biblical Hebrew, the Mishnaic tense system reflects past, present, and future tenses, and fewer aspects. It introduces a new means for marking the present participle aspect by adding the verb “to be”. For example, *hayiti* ‘I was’ *kotev* ‘writing’.

According to Kutscher (1982), only 50% of the Mishnaic vocabulary is identical with Biblical Hebrew, although, as noted, a significant number of words first appearing in Mishnaic literature had probably been already in use in the Biblical era but did not make their way into the Bible because of its limited scope. Biblical words associated with agriculture were generally retained in Mishnaic Hebrew, whereas new words associated with commerce and handicrafts were first introduced in the later phases. Thus the Mishnaic vocabulary expanded considerably, including words needed for urban life.

A large number of nouns and pronouns acquired a new Mishnaic form (or synonym). For example, a Mishnaic equivalent for the Biblical word ‘tree’ is ‘*ilan*’. But Mishnaic Hebrew also absorbed a substantial number of Greek and Aramaic words (and some Latin). The pronunciation of some Biblical words was occasionally changed. For example, certain Biblical words ending in /m/ were changed in Mishnaic Hebrew to end in /n/, for example, *kor'im* ‘are reading’ (pl.) became *kor'in*. The Mishnaic verb system eliminated the use of one of the *binyanim*, namely *pu'al*, and added some others (Kutscher, 1982). The writing of Mishnaic Hebrew, like that of some of the Dead Sea scrolls, also made extensive use of vowel letters.

Medieval Hebrew

Although generally no longer a spoken language, there were significant developments in the history of Hebrew as used for reading and writing in the Middle Ages. One of these developments is the inception of diacritical vowel signs.

As discussed in greater length in chapter 3, the Proto-Canaanite, the Canaanite, and the Phoenician writing systems that the Jews presumably employed once they started to write in Hebrew, consisted of consonants only. Although it seems difficult to determine at what time Hebrew texts became clearly distinguished from local Canaanite writings, it seems, as we noted earlier, that from the beginning of the first millennium BCE Hebrew texts began to make limited use of vowel letters. But this device was insufficient to ensure a precise representation of how most Hebrew words should be pronounced by those who no longer spoke the language. Of the four vowel letters, the glottal stop sign *aleph* functioned as a kind of vowel place holder, indicating /a/, /i/, /e/, /o/, or no vowel. The letter *he* was used as a vowel let-

ter only in word endings, marking /a/, /e/, or /o/. The letter *vav* was used to indicate /o/ or /u/; and *yod* marked /i/ or /e/. In addition, all vowel letters marked only what historically were considered long vowels (but see Blau, 1976). The short vowels were not marked at all, and no vowel letter was designed specifically to mark the vowel /e/. The vowel letter system did not fully indicate pronunciation of unknown words. Some believe that at this time in Jewish history only a small number of professional readers were able to recite the Bible in the synagogue without the involvement of their contemporary vernaculars—Aramaic or Mishnaic Hebrew (Kutscher, 1982).

Furthermore, after the Arab conquest of the 8th century CE, Jews wishing to read the Bible, Mishna, or Talmud for religious purposes needed to comprehend and recite languages they no longer spoke. Accordingly, vowel signs were badly needed to complement vowel letters in securing a precise reading and conventional interpretation of the sacred texts. The vowelization of the Bible by the Masoretes (see above) may thus be regarded as the final, concluding effort in the canonization of the Jewish scripts.

As discussed in detail in Blau (1976), at one time or another four ways of marking (pointing) vowels by diacritics '*nekudot*' (points) existed: the Tiberian, the Babylonian, the Palestinian, and the Samaritan. All systems but the Tiberian marked the vowels above (and between) the consonant letters. If one writes from the top of the page down, first writing the consonants (for they are much more informative), marking above-the-line signs may be a problem when insufficient room is left for them between the lines. Perhaps for this reason eventually only the Tiberian vocalization was retained (although Samaritans continue to use their own system and Yemenite Jews used the Babylonian system until recently).

The other important development in the history of Hebrew in Palestine during the medieval period occurred toward the middle of the first millennium CE (perhaps as early as the third century): the evolution of a new genre of religious poetry—the *piyyut* (pl. *piyyutim*). The *piyyutim* were hymns appended to the larger set of prayers recited in synagogue services. *Piyyutim* writing spread from Palestine to the Diaspora, where it continued for several centuries. Although the content of the *piyyutim* sometimes alluded to the Midrash, their language was mostly Biblical Hebrew (including the least common words), together with some Mishnaic and Aramaic expressions. The poets (*paytanim*) allowed themselves a great degree of freedom in creating new forms of words for their *piyyutim* derived from Biblical roots, thus augmenting the Hebrew vocabulary.

Other literary creations in Hebrew in the Middle Ages were generated in the Diaspora. First and foremost was the monumental creation of Hebrew poetry originating in Spain (10th–13th centuries CE) and later in Italy, but also important were treatises on Jewish grammar and the compilation of dic-

tionaries of Biblical Hebrew. These contributions resulted from a growing interest in the Hebrew language by Jewish scholars of the time, apparently kindled by their acquaintance with Arabic literature, particularly poetry and the work of Arab linguists of this time.

The poetry written in Spain and Italy by poets such as Shmuel Ha-Nagid, Shlomo Ibn Gabirol, Judah Ha-Levi, Moshe and Abraham Ibn Ezra, Emanuel from Rome, and others was not solely devoted to religious themes but also dealt with secular matters. Their writings were influenced by contemporary Arabic poetry both in the choice of topics and adoption of Arabic literary forms. The language they used most was Biblical Hebrew; although unlike the composers of the *piyyutim*, they tried to be faithful to Biblical morphology and grammar (they did allow themselves some latitude in playing with word meanings for poetic purposes). Their main effort was to extol the Bible's beauty and language, somewhat akin to the Arab poets who extolled the Arabic of the Qur'an. Some of these poets incorporated Mishnaic Hebrew in their poetry.

Continuous Use of Hebrew Throughout the Ages

The revival of Modern Hebrew occurred in a less miraculous fashion than is commonly, and somewhat mythologically, portrayed. Reading Hebrew continued without interruption throughout the generations as a central and integral part of religious services in every Jewish synagogue or household around the globe. In addition to the liturgy (most prayers are traditionally in Hebrew), the language was used for artistic, religious, social, or scientific purposes. For example, at the time when most Jews in Palestine resorted to Aramaic for daily speech and scholarly creation, such as the composition of the Talmud (from the 3rd century CE), the Hebrew literature of the *piyyut* also emerged, and continued for centuries thereafter. In the Middle Ages, when Jews in the Diaspora began to speak Arabic, the writing of Hebrew poetry was established in Spain and Italy. It is fair to assume that these writings enjoyed some audience and readership, however small or large.

Concurrently, during the era of artistic creation and scientific writings in Hebrew in Muslim Spain, important works in Hebrew on religious matters were being written in the Diaspora in Babylon. The most prominent example is the work of religious leaders such as Rav Sa'adia Ga'on, who wrote belles-lettres (*piyyutim*) and polemical texts in Biblical Hebrew; he also compiled a Hebrew dictionary. Sa'adya Ga'on was among the first to establish a new Hebrew genre of rhymed prose. In addition, a great treasure of Hebrew books dating back to this time, the *Geniza*, was found in a sanctuary for sacred writings in a Jewish synagogue in Cairo.

Beginning from the 10th century CE, intensive writing in Hebrew emerged in Europe penned by religious leaders such as Rabenu Gershom, Rashi, and others. They wrote fine literature (e.g., *piyyutim*) as well as religious matter such as interpretations of the Bible, the Talmud, and the Midrashim. European Jews developed an interest in philosophy and science. Apparently in response to popular demand, Jewish scholars began writing books on these subjects in Hebrew, and also translated books from Arabic (and later from Latin) into Hebrew. We know of about 180 scholars who translated more than 1,000 texts into Hebrew. It is worth noting that the most prominent medieval writer on Jewish law (*halakha*), Maimonides (14th century) wrote only one of his books (*Ha-yad Ha-hazaka*) in Hebrew, and had professional translators render his other works into Hebrew. Hebrew speech in a more popular dialect of Hebrew also developed in Europe between the 10th and the 14th centuries.

The Revival of Hebrew in the Diaspora

In 16th century Italy we find the first drama written in Hebrew, by the playwright Jehuda Somo. From that time on, books too were written in Hebrew by Jews who lived in Holland. In the 17th century, Hebrew books appear written in Berlin, where a Hebrew school and printing house were also established. The most famous scholars who wrote Hebrew in Berlin were Naftali Hertz Weisel and Moses Mendelssohn. Interested in promoting the values of the Hebrew enlightenment (*Haskala*) among their fellow Jews, these writers and their followers established in Berlin a periodical, *Hameasef*, which contained texts written in Hebrew.

As efforts to spread the *Haskala* continued in Prague, Galicia, and Hungary, another movement, *Hasidut*, also began incorporating Hebrew in some of its texts. In the 18th and 19th centuries, a great deal of Hebrew was written by Lithuanian Jews, principally Avraham Mapu. Mapu was a leading writer of books, and he founded several new Hebrew periodicals. In a number of these (*Hamagid*, *Hamelitz*, *Hamevaser*, and *Hatzfira*), important innovations were introduced in an effort to cope with the needs of modern expressions in Hebrew. At that time, Jewish scholars active in the *Haskala* movement attempted to establish a Jewish secular culture. Languages spoken locally (e.g., German) were not suitable for this enterprise because most Jews were not proficient in them, and Jewish colloquial languages, such as Yiddish, were incompatible with their ideology because of its association with traditional leadership. They consequently turned to Hebrew, aspiring to make it instrumental in a national renaissance.

These secular scholars wanted the language they used to appear as genuine as possible, thus they limited themselves to Biblical Hebrew, and deliberately avoided Mishnaic Hebrew or the Hebrew used in Rabbinic literature.

Note that, driven by the goals of enlightenment, the *Haskala*, the use of Hebrew was aimed at satisfying a limited goal, that of transmitting modern values. Indeed, once Jews had become more conversant with the local languages, the *maskilim* (promoters of the *Haskala*) urged their followers to abandon Hebrew in favor of local tongues that were better suited to open the gates to modern civilization.

Yet secular literature in Hebrew continued, and toward the close of the 19th century it was bolstered by the emergence of the Zionist movement, which called for the transformation of “the old Jew” through a comprehensive change of lifestyle, occupation, and culture. Many (though not all) Zionists saw the return to Hebrew as an integral part of Zionism. These Zionists found much inspiration in the fiction of the highly gifted writer Mendele Mokher Sefarim (born Sh. J. Abramowitz, 1835–1917), who, singlehandedly, produced a whole new form of literary Hebrew. His success in writing lively and inspiring prose in Hebrew may have resulted from the unrestrained liberty he permitted himself when drawing on every stratum of the Hebrew language as well as other languages spoken by Jews, such as Yiddish (some of his early books were written in Yiddish). Freed from all artificial constraints, and unlike his predecessors who, in Kutscher’s words “often wrote not what they intended to write but what they were able to write” (1982, p. 190), Mendele wrote in a style that spoke to the ordinary and sophisticated reader alike and made use of the entire development of Hebrew throughout its long history. Combining all these sources, he was able to craft something of his own, to forge a new style, indeed a new genre of literary Hebrew. The success of Mendele Mokher Sefarim in writing Hebrew fiction was soon matched by several essayists, of whom Ahad Ha’am (born A. Ginsberg, 1856–1927) is the most famous example.

Thus, Mendele as a bellettrist, and Ahad Ha’am as a publicist, together with their many followers, helped cast the styles and linguistic registers of Hebrew as a newly written language. Hebrew as a spoken language was of course another matter: At the end of the 19th century various associations emerged in Europe promoting its revival as a spoken language. At the beginning of the 20th century, day schools were established in Poland and Lithuania where Hebrew was at least partly the language of instruction. Although none of the graduates made Hebrew their main language for everyday purposes, they were nevertheless well prepared once such a means of communication revolution did come about in Palestine.

Clearly then, the revival of spoken Hebrew in Palestine toward the end of the 19th century relied on previous and successive attempts to preserve Hebrew reading and writing down the centuries, beginning with the destruction of the Second Temple. They persisted until the time when a sufficient number of Jews were to return to Palestine and make Hebrew, once more, their primary, multipurpose language.

The Revival of Modern (Israeli) Hebrew

The person who has gone down in history for transforming Hebrew from primarily a literary language into an all-purpose one is Eliezer Ben Yehuda (born Perlman; 1858–1922). Ben Yehuda was both a scholar and a charismatic figure. In 1879, while still in Europe, he published a programmatic article in the Hebrew periodical *Hashachar*, in which he called for a Jewish renaissance in Palestine with Hebrew as the main language. Ben Yehuda was not inspired by the same motivation that propelled mainstream Zionism, but by European nationalists for whom the national language was pivotal in forging a national identity. He did not necessarily advocate the ingathering of all Jews in Palestine; instead he envisaged Palestine becoming a Jewish center, enabling the national language and its culture to survive and flourish.

Ben Yehuda immigrated to Palestine in 1881 and settled in Jerusalem. As a teacher, he may have not been the first to teach Hebrew using a holistic—“Hebrew through Hebrew”—method (see Haramati, 1978). But what made him so influential, and indeed rightly entitles him to be remembered as the initiator of the revival of Hebrew in Israel, was that he made Hebrew the sole language spoken at his home in Jerusalem; thus, after 1,700 years, his children were the first generation who again acquired Hebrew as their first and native language. Gradually other families followed his example, and as several kindergartens and eventually schools (both became the major factor) agreed to conduct all their activities in Hebrew, the community of Hebrew speakers among the Jews living in Palestine burgeoned at a rapid pace.

In 1882, a year after his arrival in Palestine, Ben Yehuda, together with other educators, inaugurated the *Texiyat Israel* association, one of whose principal tenets was the revival of spoken Hebrew. Eight years later it was reported that teachers were teaching “Hebrew through Hebrew” in elementary schools in northern Israel. In 1882, the Jewish teachers’ association decided to teach all subjects in Hebrew at all the Jewish schools in Palestine. Two modern high schools, established in Tel Aviv (1905) and Jerusalem (1907), taught all subjects in Hebrew from the start. In 1890, Ben Yehuda set up a “language committee” (*Va’ad Halashon*), later to become the Hebrew Language Academy, which supervised the creation of new Hebrew words required for daily communication in modern life and also set the standards for pronunciation and printing. Around the turn of the century, Ben Yehuda began working on a monumental project, a comprehensive dictionary with etymological references for every known word in Hebrew; he worked on it continuously until the end of his life. The work eventually comprised 16 volumes and was only completed 37 years after his death.

A discussion of the revival of Hebrew must no doubt also account for sociocultural conditions. As the Zionist movement attempted to attract more and more Jews to join the settlers in Palestine, it faced a problem of commu-

nication. Jews in Palestine spoke many languages, and those still in the Diaspora spoke an even greater number. Therefore, adopting a modern language such as English, French, or German as the agreed language for all, would certainly be advantageous in terms of accommodating the contemporary requirements of communication, but would be difficult for those who did not speak that specific tongue. The choice of language would also involve interminable controversy. The only language that ultimately most Jews could agree on as common to them all was Hebrew.

The choice of Hebrew coincided with the aspirations of many newcomers who strove to reshape the image of the old Diaspora Jew into that of the mythical Hebrew individual of the Bible. They wished to transform Jews who had previously made their living from small trade and who spoke a Jewish jargon (e.g., Yiddish) into agricultural workers, living on the Biblical land and speaking Hebrew. Hebrew was also the language that most Jews had at least some knowledge of, mainly acquired through participating in religious services and the like. Moreover, in appropriating a new language, it is always easier to build on established foundations than to start anew. The enthusiasm of leaders like Ben Yehuda and his followers, particularly the teachers of that period and the newly arrived pioneers, assured the success of what proved to be a well-calculated decision.

Modern (contemporary) Hebrew, the language developed in Palestine/Israel during the 20th century, draws its sources from all strata of the Hebrew language and has absorbed a large number of new words. Some of the neologisms were formed from Semitic roots (Hebrew, Aramaic, and sometimes Arabic) and creatively cast in *binyanim* and *mishkalim* (see chapter 2) in ways that were consistent with the rules of Hebrew morphology. Other new words were imported from foreign languages and, where possible, these too were recast in Hebrew structures. For example, Hebrew speakers use the international noun for “telephone,” but they also lexicalize telephone as a verb. In Hebrew “I phoned” is *tilfanti*, an inflection in the *binyan* called *pi’el* and consistent with the rules of Hebrew morphology.

In drawing on the diverse heritage of historical Hebrew, modern spoken Hebrew acquired most of its words from Biblical texts. According to Rabin (1973), 80% of the 1,000 most frequent Hebrew words are of Biblical origin. Because of media reporting on current events and the smooth reception of new and international words, the share of Biblical words in newspapers is somewhat lower (60%–70%). Recent Israeli Hebrew dictionaries contain more than 60,000 words. A large number of these are from the approximately 8,000 words of Biblical Hebrew. Of the post-Biblical vocabulary, 14,000 words are of Mishnaic, Talmudic, and Midrashic sources, and about 6,500 words are from medieval sources. A few thousand words come from Aramaic, most of them used in the Talmud. The number of new words in a recent dictionary (words formed since the late 19th century) is about 15,000.

In reality it is probably much higher, because general dictionaries do not normally include technical terms used in specialized domains. Also, dictionaries usually lag behind vocabulary development—all the more in respect of a language that is so rapidly expanding.

Finally, although most Biblical words have found their way into Israeli Hebrew, when choices have to be made between Biblical and Mishnaic equivalents, usually the Biblical word is favored, together, in most cases, with its conjugations and declensions. However, as regards grammar and syntax (particularly the tense system and word order), Israeli Hebrew is closer to Mishnaic Hebrew. Not that Mishnaic grammar was deliberately weighed up against Biblical grammar and preferred: Most Modern Hebrew speakers, particularly nonreligious youth, were more familiar with Biblical than with Mishnaic texts. The reason may be that Mishnaic grammar was easier to conceptualize and utilize in terms of the modern (European) languages with which they were familiar. Be that as it may, Modern Hebrew verbs are less recruited to express consecutive tenses, as in the Bible, and better lend themselves to the simple past, present, and future tenses. To express the consecutive option, Israeli speakers often employ a combination of the verb (usually in a simple present form) and the auxiliary “to be”—*lihyot*. For example, “I will be ready” is in Hebrew ‘*ehye muxan*’. “I was ready” is ‘*hayiti muxan*’.

Modern Hebrew presently develops similar to the development of other modern languages, in terms of the expansion of its vocabulary, resulting from the advanced means of digital communication and world globalization. It smoothly absorbs foreign words and new forms of speech.

6

The Evolution of the Hebrew Writing System

The earliest texts written in Hebrew may be traced as far back as the 13th century BCE. Significant revisions and supplements to this pristine form of writing in Hebrew were introduced only about fifteen hundred years later, or some twelve or thirteen centuries ago. Interestingly, texts from even the earliest times can be read and comprehended by present-day readers of Hebrew. The complete Hebrew writing system is known as the Masoretic text or Tiberian Hebrew. It consists of 22 consonant letters and a set of diacritical marks comprising vowel signs and cantillation marks. Prior to the Masoretic contribution, Hebrew was constituted primarily of the set of the 22 consonant letters together with initial, not yet systematic, attempts to indicate vowels by assigning a second role to four consonant letters (see later on vowel letters). The contemporary Hebrew speaker in Israel generally reads orthography similar to the early writing system. It consists of the 22 consonant letters, and at times employs the vowel letters to mark some of the vowels (mostly /i/, /o/, and /u/, and occasionally /a/) in some of the words. On rare occasions this reader encounters a fully vowelized text, one that contains diacritic marks (e.g., poetry, religious texts, and children's books). Apparently, as indicated in chapter 3, the contemporary Hebrew speaker is quite proficient in reading an elliptic alphabet in which not every vowel is represented. This chapter provides a short review of the evolution of the Hebrew alphabet. It is mainly focused on the inception of the alphabet and the contemporary writing in Hebrew.

THE EVOLUTION OF THE HEBREW ALPHABET

The Hieroglyphic Model

The foundation for the Hebrew writing system is closely linked to the origin of the alphabet, more than three and a half millennia ago. In fact, some of the letters of the first exemplars of alphabetic writing are almost identical in shape to the early Canaanite and then Hebrew characters.

Recent work by Sass (1988, 1991, 1993) supports the view (cf. Gelb, 1952) that the alphabet evolved from the Egyptian hieroglyphic writing system at the time of the Twelfth Dynasty (Middle Kingdom in Egypt, Middle Bronze Age in archaeological terms), about the 18th century BCE. In earlier accounts, Albright (1966) dated the origin of the alphabet to the 15th century BCE but allowed for a possible earlier dating (p. 15). Most researchers support the later dating (Cross, 1967; Naveh, 1982). How might the alphabet, a graphemic representation of phonemes generally restricted to 20 to 30 characters, have been inspired or influenced by the Egyptian hieroglyphic writing system, which contains far more signs?

Egyptian hieroglyphics (Greek *hieros*=holy, *glyphein*=carving) consist of more than 600 signs. This is, of course, a great deal more than the number of alphabetic signs, but also far fewer than the number of words in the Egyptian language. The hieroglyphic system had, in fact, incorporated a mechanism that reduced the number of signs its readers and writers needed to store in memory. What made the hieroglyphic writing system more economical was that it contained a mixture of ideography and phonography, that is, consisting of semantic and sound markers standing for words. As Egyptian writing evolved, a reduction in the number of signs became possible through the combination of semantic determinatives and phonograms. Diringier (1968) classified hieroglyphic signs into three groups: (a) word-signs, (b) phonograms and phonetic complements, and (c) determinatives (see Fig. 6.1).

Word-signs were symbols that stood specifically for an object or an action. For example, a schematic ellipse with a dot in the middle represented an eye. This same symbol with three strokes running down from its center, like falling tears, stood for crying. Phonograms were again schematic depictions of objects, except that the symbols stood as well for the sounds of the words that named these objects. The sounds of the word were borrowed to represent other words with the same sounds. In essence, phonograms stood only for the consonants of that word, so that a rectangle symbol schematically depicting a house, written with the consonants /p/ and /t/, say, actually stood for the pair of consonants /p-r/. It could be used for writing "house" in Egyptian but also for writing other words whose consonants, or at least some of them, happened to include the sequence /p-/t/. Most Egyptian words con-

- | | |
|--|--|
| (1)  = leg |  = eye |
| (2)  = to go |  = to weep |
| (3)  = p-r (house) |  = n-b (basket) |
| (4)  = r (the mouth) |  = s (folded cloth) |
| (5)  = (identifying)
plant
(sphere) |  = (identifying)
water
(sphere) |

FIG. 6.1. Hieroglyphics signs. (1) Signs denoting objects. (2) Signs denoting actions. (3) Signs denoting objects and biconsonantal phonograms. (4) Signs denoting objects and uniconsonantal phonograms. (5) Signs denoting objects and semantic determinatives. Adapted from Gaur (1984) by permission of the British Library.

sisted of two or three consonants. Thus some 75 signs came to represent syllables with two consonants.

A particularly important group of hieroglyphs consisted of 24 signs representing single consonants. Some of these, again, originally represented words of one consonant. The development of other uniconsonantal phonograms is not entirely clear. Some signs were perhaps created by the acrophonic method (discussed in the next section) that was already employed by the Egyptians in cryptographic writing. What seems clear is that all these signs stood for consonant combinations in writing other words. That is, the group of 24 single consonants stood for all the consonants that existed in the Egyptian language, and in fact constituted all the components of an alphabet (except vowel signs) even though they were not used in systematic and basic alphabetic writing. When used alone this was mostly for writing the names of foreign peoples; a list of foreign peoples from that period would meet the requirements of an alphabetic text.

The third group of Egyptian hieroglyphs, the semantic determinatives, were used to denote senses. The need for such symbols arose because many phonograms, by representing only consonants, were homographs—different words written with the same symbols. To mark a specific word denoted by these phonograms, a complementary symbol indicating the semantic field associated with the word was attached to the particular phonogram so as to “disambiguate” it, namely, making its identity as a spoken word unambiguously clear. Thus, a symbol depicting leaves was used to indicate the semantic field of plants; a sign sketching a book roll represented abstract concepts.

In general, Egyptian scribes combined word-signs, phonograms, and determinatives, fostering redundancy as if to ensure that their message came

across. Economy was sacrificed for the sake of comprehension and unequivocalty. For example, a word-sign could be accompanied by phonograms and determinatives that were semantically redundant. However, as indicated earlier, there is some evidence that at some period in Egyptian history words were written in a manner that, for all practical purposes, can be regarded as alphabetical.

As noted, this development took place at the time of the Twelfth Egyptian Dynasty in the Middle Kingdom, about the 18th century BCE, and the purpose of this “alphabetic” practice was to list the foreign names of Western Asiatic places, rulers, and slaves. These names appeared in the writing of execration texts, namely, texts containing curses cast on rulers of foreign lands. Such texts were found in Egyptian cities such as Thebes (Sethe, 1926), Saqqara (Posener, 1940), and Mirgissa (Posener, 1966). Another source was a list of Semitic slaves (Albright, 1954), and one more was a number of inscriptions of Semitic names found in the Sinai desert (Sass, 1988).

It is not surprising that in writing texts consisting of lists of foreign names, the Egyptians could not use word-signs or semantic determinatives that reference local entities. But interestingly, there was also little presence of bi- and trilateral signs or syllabic writing (typical of later Egyptian writing) in these protoalphabetic texts. In addition, unlike previous Egyptian writing, these texts already contained a fair number of vowel letters, which stood for the vowels /a/, /i/, and /u/. Of course, the presence of vowel signs makes more sense in the context of consonantal alphabetic rather than syllabic writing, which usually specifies both consonants and vowels. Nevertheless, the Egyptian protoalphabet contains some syllabic signs, and their presence is explained by Sass as rooted in the Akkadian influence on Egyptian scribes who were exposed to that language and transcribed its words into syllabic signs.

An interesting question is why, although their alphabetic writing was well tried and tested, and, according to Sass (1991), “what was left to be done consisted mainly of technicalities,” the Egyptians eventually abandoned the practice of alphabetic writing in favor of syllabic writing. There is no explanation to this puzzle (perhaps the power of the tradition or the conservative approach of the scribes). However, practices abandoned by Egyptian scribes were picked up by the Semites who traveled to Egypt and whose writings were preserved in the Sinai desert as well as at a number of sites in Canaan, in what is today Israel.

The Earliest Examples of Alphabetic Writing

The earliest exemplars of alphabetic writing were found in a relatively small area, stretching from the Sinai desert in the south, through Canaan, to Phoenicia in the north. So far, approximately 60 inscriptions have been discovered in these early writings. About half of them were found in the Sinai

desert and are called Sinaitic inscriptions, and the other half, from farther north, are called proto-Canaanite inscriptions.

Findings in the Sinai Desert. In 1905, Sir Flinders Petrie was the first to discover alphabetic writing. The findings included about a dozen inscriptions in an unknown pictography detected in Serabit el-Khadem, an ancient turquoise mine in Sinai. Petrie suspected that the inscriptions he found were indeed early alphabetic writing. He tentatively dated them to about 15th century BCE, but was unable to decipher them. About 10 years later, Sir Alan Gardiner was successful in deciphering one word; from this achievement he pieced together the principles on which these writings were based.

Gardiner noticed that the pictograms were figuratively similar to Egyptian signs on the one hand and to the Phoenician letters developed later on the other. He suspected that they stood for local Semitic words and he attempted to decipher them, believing that they represented Semitic phonemes extracted from a Semitic language through acrophony—a phonemic representation based on the first phoneme (normally a consonant) of the word. Thus, the pictogram in the form of a rectangle stood for “house” in Egyptian hieroglyphic writing and was deciphered by Gardiner as being associated with the Semitic word house, *beyt* or *bayit*, whereas the sign itself, through the principle of acrophony, stood for the phoneme /b/.

By drawing these parallels between the meanings of Egyptian pictograms and the first phonemes of Semitic words bearing the same meanings, Gardiner managed to decipher one word that reappeared several times in Petrie’s inscriptions. The word was *Ba’alat*, the name of a goddess, to whom gifts were offered. Gardiner’s decipherment was supported by his discovery of a revealing inscription written in both Egyptian and Sinaitic, carved in stone on a small sphinx (see Fig. 6.2). The Egyptian text read: “Beloved of Hathor (lady of) Turquoise.” The two inscriptions, even if not literal translations, were testimony to the sculptor’s dedication to a goddess, first in her Egyptian name and then in the Semitic equivalent. The word *Ba’alat* appeared in other inscriptions found in a temple of the goddess Hathor.

As indicated, Gardiner, in his first decipherment, also benefited from the graphic similarity between some of the signs and several already familiar Phoenician letters. Indeed, the four consonantal signs of the word *Ba’alat* are graphically similar to Phoenician and early Hebrew letters: *bet*, *ayin*, *lamed*, and *tav*.

When Gardiner published his first decipherment of a proto-Sinaitic inscription (1916), the number of letters reliably identified was still rather small. This prompted some skepticism among experts (cf. Dinger, 1968, pp. 148–150), but as the number of findings gradually increased the objections subsided. By 1948 Albright could identify 18 (out of 27) signs, and about 20 years later (1966) he claimed identification of almost all the letters (although

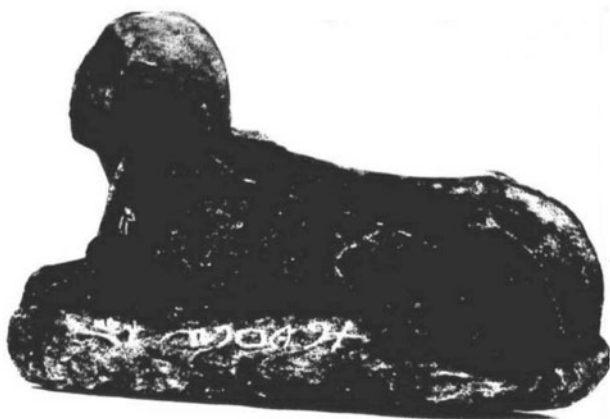


FIG. 6.2. A Proto-Sinaitic inscription on a sphinx found in the Sinai desert. The letters lamed, bet, 'ayin, lamed, tav (leba'alat), from left to right, are inscribed at the bottom.

graphemes standing for /z/, /t/, and /s/ remained undiscovered). Nevertheless, evidence continued to accumulate, and by 1988 Sass could publish previous identifications (mostly Albright's) together with new evidence found at later dates in Sinai (including his own), successfully listing 22 letter identifications, of which only five required additional verification.

Findings in Ancient Israel. Not far from Sinai, in what is today Israel, Lebanon, and Syria, a number of early alphabetic inscriptions were also unearthed. Particularly important were the writing on a dagger found in Lachish (see Fig. 6.3), three characters inscribed on a shard found in Gezer (see Fig. 6.4), and the writing on a fragment of a plaque found in Shechem (Nablus). Compared with the writings of the Sinaitic texts, these Canaanite texts more reliably preserve the pictographic origin of early alphabet letters.

An example is the *resh* on both the dagger and the plaque: It is a more detailed sketching of a head (in Hebrew, *rosh*). Similarly, the *kaf* (in Hebrew, *palm*) on the shard from Gezer is an unmistakable drawing of the palm of a hand. Because these artifacts were more pictographic than the texts from Sinai, some researchers consider them older than the Sinaitic texts (e.g., Naveh, 1982; Demsky, 1997). Be that as it may, they certainly seem to reflect a crucial link in the development of the alphabet, namely the transition from pictographs to linear letters.

Sass (1988) described 25 proto-Canaanite inscriptions. Unlike proto-Sinaitic inscriptions that, as a rule, were engraved in stone, the proto-Canaanite inscriptions were written on a variety of materials. Most of them were inscribed or incised on clay or shards, but some were engraved on weapons such as daggers or arrowheads (see Fig. 6.5). It is reasonable to assume



FIG. 6.3. A proto-Canaanite inscription on a dagger found in Lachish. The second sign from the top is a pictograph marking the letter resh, the first consonant in the Hebrew word rosh 'head'.



FIG. 6.4. A proto-Canaanite inscription on a shard found in Gezer. The three characters from top down mark kaf, lamed, and bet. Note the pictographic nature of the characters kaf 'palm', lamed 'Shepard's stick', and bet, 'house'.

that many more inscriptions had been written on papyrus, hence did not survive the climatic conditions of these areas. Nevertheless, in the collective paleographic evidence from Sinai and Canaan, the graphemic representation of the language in these writings appears complete. A definite graphic continuity may be detected between the letters of Sinai and those of Canaan. It seems quite probable that at the beginning of the second millennium BCE, somewhere in this geographic region, lived the inventor of the alphabet.

The most important lesson that this inventor had learned from Egyptian scribes was the focus on phonemic representation. It was this focus that en-

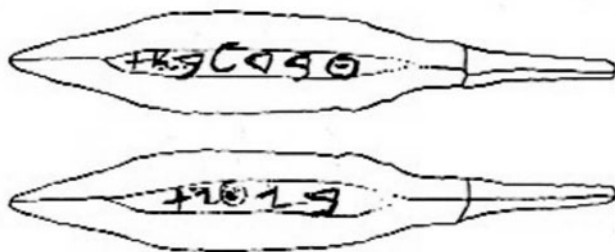


FIG. 6.5. The dart of 'Abdlabit' (servant of the Lion Lady). Two sides of a bronze arrowhead from the late 12th century, found near Bethlehem. The characters ?bdlbat are engraved from right to left on one side (top), and the characters bn?bt (bottom) are engraved on the other side. The writings on these inscriptions are believed to reflect the link between the pictographic and linear characters of alphabetic writing. For example, the letter ? ayin 'eye' on the arrowhead appeared not just as a circle, which later evolved and finally assumed the form of the Greek and Latin O, but was also dotted in the center, signifying the pupil of the eye.

abled Egyptians to write foreign names and encouraged Semites visiting or working in Egypt and Sinai to experiment with a genuine alphabetic system. The emphasis on phonemic representation (one grapheme representing one phoneme) made possible "the conquest of the alphabet" from Ireland to India in ancient times, and then to the "New World," Australia, and so on. All alphabets are derived (via the Greeks and the Arameans) from the Canaanite-Sinaitic-Phoenician original.

The Hebrew Writing System

When the Hebrews came to reside in Canaan, around the 12th century BCE, they encountered proto-Canaanite writing and a more stylized derivation of it that had evolved in Phoenicia. They probably also found a competing version of alphabetic writing inscribed in a cuneiform script. The most abundant collection of such texts was found in Ras-Shamra on the Mediterranean coast of North Syria, the site of the ancient city of Ugarit. Although cuneiform writing was also found at other Canaanite sites (e.g., Beit Shemesh, Ta'anach, and Tabor), the Hebrews did not adopt the cuneiform alphabet but opted for Canaanite-Phoenician writing. They may have also been inspired through intermediaries by the idea of indicating vowels by graphemes as in Ugaritic writing, and they may have conferred a secondary role of vowel representation on several consonant letters. This principle was rarely upheld by the Phoenicians themselves (but note that Ugarit itself was destroyed before the earliest appearance of Hebrew texts).

At that time the archaic pictograms of the proto-Canaanites gradually evolved into more linear, letter-like characters. In most cases the writing was expressed in horizontal lines and the direction of writing was from right to left. For about 200 years the letters used for writing Hebrew were indistinguishable from Phoenician letters. A Hebrew document found in Gezer describing the agricultural calendar was written in typical Phoenician letters (see Fig. 6.6).

Oddly enough, the first evidence of what was later to be recognized as typical Hebrew writing is a stele erected in honor of King Mesha (who is mentioned in the Bible: II Kgs. 3:4ff.) found in Moab, in present-day Jordan (see Fig. 6.7). Although the language of the stele is Moabite, the writing is in Hebrew letters typical of later Hebrew writing, and can already be distinguished from Phoenician writing. The Moabites at the time might have been under the cultural influence of the Israelites (as it would appear from the Biblical narrative).

It seems quite certain that only a relatively poor crop of texts remains from the first 400 years of Israelite settlement in Canaan because most of the

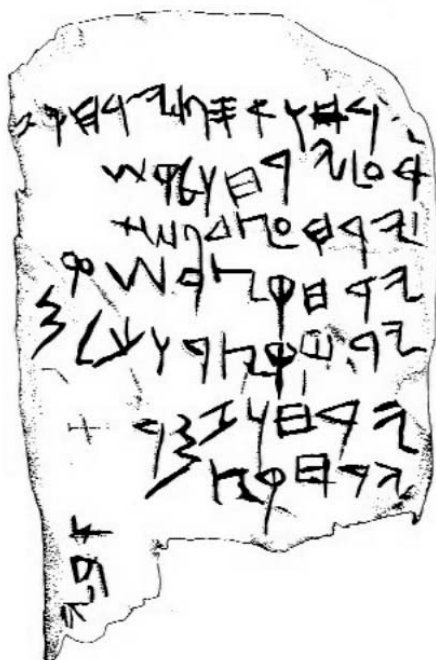


FIG. 6.6. A Hebrew document found in Gezer describing the agricultural calendar, written in typical Phoenician letters from right to left, mentioning 8 months (yeraxim).



FIG. 6.7. Hebrew writing on a stele erected in honor of King Mesha, found in Moab.

writing was done on parchment. This material could not withstand the climate of central and northern Canaan. The only place in Canaan where parchment could endure the rigors of time was the Judean desert, where very few people lived—mostly nomads, and where hardly any urban culture could develop. There a growing number of inscriptions from the 8th century BCE onward have been found.

Another reason for the dearth of texts in Hebrew from this period is the Israelites' failure to develop a standard of writing on monuments. They did not erect monuments in the name of kings or of God, and indeed, most Hebrew writing of the time was cursive rather than lapidary, even when incisions were made on hard material. When texts eventually did begin to appear in abundance, a great many of them (such as the collection of letters found in Arad and Lachish) were written in ink on shards. Such inscribed fragments are commonly known as *ostraca* (sing. *ostrakon*).

When Aramaic became the formal language of the Assyrian and Babylonian empires, many nations under their control began writing in Aramaic characters. Jews continued to write almost exclusively in the old Hebrew characters until the 3rd century BCE. The texts found on the Qumran scrolls from the Judean desert signal the triumph of Aramaic characters, although the consequences of this transition were not very significant. The Aramaic characters used for writing Hebrew—known today as square Hebrew

or the Jewish script—correspond perfectly, in function and name, to the old Hebrew writing, preserving a great many of Phoenician letter shapes.

Writing in old Hebrew letters continued for some centuries. In several of the Qumran scrolls—primarily written in the aforementioned Jewish script—the letters for writing the names of God were written in old Hebrew characters (see Fig. 6.8). Furthermore, Jewish leaders who sought to renew Jewish independence from the Roman empire also resorted to the old Hebrew letters, inscribing them on the coins they minted, apparently in an effort to rekindle national sentiment. Old Hebrew writing was abandoned after the second century CE, although the square Hebrew script has remained in use to this day. In fact, graphic modifications of letter shape in this system were kept to a minimum, so that with very little effort contemporary readers of Hebrew can still read the Judean Desert scrolls and other texts written more than 2,000 years ago.

Writing Modern Hebrew

As they appropriated the alphabet, Hebrew speakers did not make immediate changes to letter forms, nor did they add or remove letters. But because there were more than 22 consonant sounds in Hebrew speech, some consonant letters—*bet*, *gimel*, *dalet*, *kaf*, *pe*, *tav*, and *shin*—served to represent two consonant sounds, namely phonemes, or perhaps variants of phonemes (allophones). Later these were recognized as distinct phonemes, and were differentiated as such, beginning with the Mishnaic period (cf. Blau, 1972). Several centuries later, with the introduction of the diacritic signs (Hebrew *nekudot*, dots, points), these consonants became distinguished by a dot written in the middle of or above the letter. As a result, the letters *bet*, *kaf*, and *pe* with a dot in their center represent the stops *bet* /b/, *qof* /k/, and *pe* /p/, respectively. In a vowelized (pointed) text (one written with the diacritical marks), without the dot these letters represent the fricatives /v/, /x/ (like the

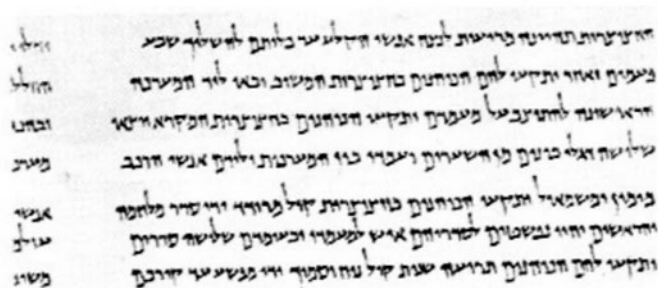


FIG. 6.8. A fragment of the War Scroll found in Qumran in the Judean desert, written in Aramaic characters.

/ch/ in Bach), and /f/, respectively. In pointed text (written without diacritical marks or dots), the exact sound presented by these letters can be only determined postlexically, from knowledge of the word and its context. For example, in an unpointed text, a word having the letters *shin*, *pe*, *resh* may be pronounced as *SaPaR* ‘barber’ or *SeFeR* ‘book’ (root consonants are capitalized here for clarification). Historically, a midletter dot also distinguished two different soundings of the three stops *gimel*, *dalet*, and *tav*, /g/, /d/, and /t/. But in Modern Hebrew, although the dot is still written in pointed text, this sound distinction is not manifested in speech. An additional characteristic is the dot on top of the letter *shin*. If it is placed above the letter’s left corner, it marks /s/ (שׁ) and the letter is sometimes called “sin.” If placed above its right corner, it marks (שׂ) “shin,” marked in this book as /ʃ/. This distinction is valid to date.

We have seen that in unvowelized texts these and other dots used for the representation of vowels, as well as most other vowel signs in the form of diacritics, are missing. In such texts, occasional Hebrew words are therefore ambiguous (homographs) and may be deciphered unequivocally only if semantic, syntactic, or pragmatic information is applied. Regarding the earlier example, the letters *samex*, *pe/fe*, and *resh* stand in one context for the word *sapar* ‘barber’, and in another for *sefer*, ‘book’.

Is such reading, with the unpointed (unvowelized) writing system, possible? Is it practical? It is certainly possible, as evinced by the fact that vowel signs were added to the Hebrew writing system only a long time—almost 2,000 years—after the system was already in use. Furthermore, most contemporary Hebrew is easily read without vowel signs. A more interesting question perhaps is how it works. This is the central issue in chapter 3.

Vowel Letters. As noted, the set of 22 Hebrew letters originally represented only consonants. However, in the course of two or three centuries of use—still a very long time before the Masoretes supplemented the system with diacritical marks—four of the letters (*aleph*, *he*, *vav*, and *yod*) acquired a secondary function indicating some of the vowels. These letters are given the Latin name *matres lectionis*, literally “mothers of reading.” Of these four, the letter *he* represents a vowel only when it occurs at the end of a word, as in *pinah* ‘corner’. The letter *aleph*, which as a consonant letter stands for a glottal stop, is rarely used as a vowel letter. But when it is, it may stand for /o/, as in *rosh* ‘head’; /i/, as in *rishon* ‘first’; or /a/, as in *bara*, ‘created’. The letters used most often as vowel letters are *vav* and *yod*; *vav* stands for either /o/, as in *šomer*, ‘guard’ or /u/, as in *šuk*, ‘market’. The letter *yod* stands for /i/, as in *šir* ‘song’ and sometimes /e/, as in *ex* ‘how’.

Unfortunately, the vowel letters do not invariably appear in writing to represent their spoken phonemes, for example, the /i/ in the word *sipur* is normally not represented in writing by *yod*. Historically, the vowel letters

were inserted to mark the long vowels only. In Modern Hebrew this distinction is no longer maintained, and the use of these characters to mark vowels is not always systematic.

The Vowel Signs (Pointed Orthography). The diacritical marks (points), together with the vowel letters, which remain incorporated in Hebrew writing, represent completely and systematically the five basic vowels of Hebrew, /a/, /i/, /o/, /u/, and /e/. In fact, they represent more. The diacritical mark *shwa* represents either the complete absence of a vowel (*shwa nach* ‘silent *shwa*’) or what was earlier a very short, semivowel (*shwa na* ‘moving *shwa*’). In addition, the *shwa*, together with the *chataf*—a semivowel—indicates what apparently once was a short or indefinite vowel. Another diacritical mark, *kamatz*, represents both /a/ and /o/. Paradoxically, Hebrew script, which initially lacked all vowel signs, now suffers from a surfeit of them (while, as indicated earlier, being short on consonant signs.) Recent attempts to simplify the Hebrew system have so far been unsuccessful (cf. Rabin, 1977).

In summary, the phonemic values of Modern Hebrew words written with diacritical marks are transparent and unambiguous. In words written without diacritical marks, the exact sounds of four Hebrew consonants (*bet*, *kaf*, *pe*, and *shin*) and of most vowels must be drawn from a memory of the word as a whole.

Orthographic Regularity. In Modern Hebrew, the representation of sounds by letters is relatively straightforward. There are, however, a few exceptions: In contemporary Hebrew, some of the phonemes may be signified by more than one letter. For example, /s/ may be represented with either *samex* or *sin*, as in the words *sipur* ‘story’ (*samex*), and *simxa* ‘Joy’ (*sin*). The phoneme /v/ may be represented by *bet/vet*, as in *levad* ‘alone’ or by *vav*, as in *davar* ‘mailman’. The phoneme /x/ (like the /ch/ in Bach) may be represented by *xet* or *kaf/xaf*, for example, *maxar* ‘tomorrow’ (*xet*) versus *mexira* ‘sale’ (*xaf*); the phoneme /k/ may be represented by *kaf*, as in *kol* ‘all’ or by *kof*, as in *kol* ‘voice’. Finally, the phoneme /t/ may be represented by *tet*, as in *texnai* ‘mechanic’, or by *tav*, as in *teken* ‘standard’.

The pronunciation of laryngeal and pharyngeal phonemes in contemporary Hebrew speech depends on dialectal differences. Speakers of Oriental descent, speaking the so-called Sephardic dialect, pronounce *xet*, and *’ayin* with lower throat (laryngeal) production, and *resh* /r/ with the tip of the tongue, as in Spanish or Italian. Speakers of European descent and, with some exceptions, most native Israelis, speaking the so-called Ashkenazi dialect, pronounce *xet* and *’ayin* in the upper vocal tract. For these speakers *aleph* (a glottal phoneme) and *’ayin* are phonetically indistinguishable, and so are *xet* and the lax *kaf* (*xaf*). In this dialect, *resh* /r/ is uvular, flat—more like the French or German than the Irish, Spanish, Italian, or Russian /r/.

A confusion between the pronunciation of *aleph* (a plosive glottal consonant), *he* (a fricative glottal consonant), and *ayin* (a fricative pharyngeal consonant) probably occurs as a result of a linguistic phenomenon known as naturalization or leveling. For example (as suggested to me by Prof. Ruth Berman), the utterance “*’arim*” may connote “I will raise,” where the correct spelling is *’RYM*, and the first letter is *aleph*; or “cities,” where the correct spelling is *’RYM*, and the first letter is *’ayin*; or “mountains,” where the correct spelling is *HRYM*, and the first phoneme is *he*. Naturalization, leveling, is a historical gradual loss of linguistic distinctions, so that forms originally contrastive become identical. For example, the traditional *vav* was apparently representing the glide /w/. When later Hebrew lost this feature, *vav* changed to represent the phoneme /v/, like the labial fricative *vet*. Similarly, *xet*, the historically pharyngeal, and *chaf*, the velar fricative, are both pronounced as /x/ (like the /ch/ in Bach) by most Modern Hebrew speakers. Leveling can be also observed in vowels. Such a process necessarily disrupts the original one-to-one correspondence between sounds and letters, as shown in the next section (also see Table 1.1).

Spelling. In consequence of less than perfect orthographic regularity, the spelling of Hebrew words is sometimes problematic. As noted, depending on hearing and pronunciation alone, speakers with the so-called Ashkenazi accent may spell wrongly in at least six ways: *aleph-’ayin-he*, *bet/vet-vav*, *xet-kaf/xaf*, *tet-tav*, *kaf-qof*, and *samex-sin*.

Spelling difficulties may go in two directions: In some cases a single letter in unpointed orthography, for example, *bet*, *kaf*, *pe*, and *shin*, represents more than one sound. In other cases, a single sound is represented by more than one letter, as in the example given in the previous section on orthographic regularity. Such “redundancy” in representing sounds occurs not only with consonants, as exemplified in the previous section, but also with vowels. The duplication of vowel representations in the vowelized Hebrew scripts results first from the existence of two systems of vowel signification, one by vowel letters and the other by diacritical marks. Secondly, a number of different diacritical marks are not distinguishable in Modern Hebrew (see Table 1.2). For example, the phoneme /a/ is represented by *kamatz* in the word *’aviv* ‘springtime’; by *pattax* in the word *’abir* ‘knight’; by *xataf-pattax* in the word *’agam*, ‘lake’; and by *xataf-kamatz* in the word *mo’avar* ‘one who is transferred’.

Consequently, due to the considerable excess of vowel signs available for representing contemporary pronunciations, correct vowelizing with specific diacritic marks (points) is fairly problematic for almost all Hebrew speakers. Only a small minority of Hebrew speakers are able to use vowel signs properly in their writing. Fortunately, unless one is a poet, a typesetter, or preparing for a test in Hebrew grammar, such knowledge is rarely called for.

7

The Viability of Literacy in Hebrew

Literacy is defined in traditional terms as the ability to read and write. My experience as a native speaker of Hebrew, like that of most children born in Israel and raised in this language, is that I could read pointed (voweled) Hebrew several months into my first year at school and unpointed (unvoweled) Hebrew very shortly after that. So at first I could see no reason why literacy in Hebrew might constitute a problem. Yet the very viability of reading Hebrew has been questioned, for example, by the philosopher Havelock (1976, 1991), as discussed later. In the following, I examine the contentions against the viability of normal literacy in Hebrew. I discuss the views of Havelock (see below) because it allows me to confront several misunderstandings about reading and writing in general and about reading and writing Hebrew in particular.

Havelock's Contention

Havelock's views on writing systems in general or early Greek literacy in particular are no longer generally accepted (see Thomas, 1992). I discuss them at some length here because they seem to reflect a commonsense view of alphabetic writing as mirroring speech sounds—a view held by many laymen, albeit in need of serious qualification, as is shown later. Havelock's reason for doubting the viability of literacy in Hebrew is rooted in the interpretation of the historical fact that the first Semitic alphabet had no signs for vowels. Based on Gelb's (1952) analysis, Havelock found Hebrew to be a unique type of CV syllabary that leaves the vowel slot empty. So a "b" character can stand for /bi/, /be/, /ba/, /bo/, or /bu/, but not for /b/ proper.

This characterization of Hebrew is, I think, erroneous. First, many syllables in Hebrew end with no vowel at all; their last consonant is not followed by a vowel. In such cases the consonant letter stands just for a consonant, nothing else. For example, the unvoweled (unpointed, accompanied with no diacritic) word spelt MTBX and pronounced *mitbax* 'kitchen' has two syllables, each of which opens and closes with a consonant: mit#bax (the sign # marks the boundary between the syllables). In vocalized (pointed) script, the vowels are rendered by a diacritic representing the sound /i/ under the letter M and the sound /a/ under the B. In addition, the syllable boundary is marked by a diacritic under the letter T representing the "silent" *shwa* sound.

Gelb (1952) suggested that zero vowel is also a vowel, noting that it is in fact so marked, when the text is pointed, with the diacritic *shwa*. Yet the consonants that are not followed by vowels at the end of Hebrew words are not generally marked with the *shwa*, so the last consonants in such words cannot be considered as CV (consonant-vowel) syllables. Therefore, if a letter can stand for a consonant only in some of the cases (where the vowel sign attached to it is a silent *shwa* [*shwa nax*] or it is positioned at the end of a word), why should we deny such a possibility in other consonants?

Second, as Jensen (1969) argued, because Semitic languages contain both CV and CVC syllables (in fact they also have CCVC and CVCC, but with lower frequency), one would expect a writing system based on syllables to include signs for both the one- and two-consonant syllables. This, however, is not the case. Therefore, the original Semitic letters cannot be said to represent a consonant-vowel (CV) syllables.

It makes more sense to construe Semitic letters as representing consonants proper (unless they function as vowel-letters; see chapter 2), and to assume that the reader, being aware of the characteristics of decoding unvoweled Hebrew, is prepared to supply the missing vowels from his or her memory of the Hebrew lexicon. In all likelihood (as elaborated in chapter 3), even written Hebrew words that consist of strings of consonant letters only (in unvoweled scripts) evoke phonemic information, which is generally sufficient for reading comprehension even though their representation of speech sounds is incomplete.

With regard to Gelb's suggestion, when unvoweled words are read, the vowels are certainly retrieved from the mental lexicon and inserted in the proper slots of the word pattern. But they are not retrieved for augmenting every single consonant by making them CV syllables. In many Hebrew word patterns, consonants appear to which no vowel is attached. Thus, the original Semitic alphabets should be simply defined as consonantal (as suggested by Driver, 1970) or vowelless alphabets.

Furthermore, strictly vowelless Semitic alphabets characterized mainly the Phoenicians, the proto-Canaanite, and the Sinaitic writing systems. By the time the Greeks adopted the Phoenician alphabet, texts in Hebrew con-

tained four vowel-letters, which, in some words, functioned as cues for vowels. True, even with the addition of the vowel-letters instances still arise where the lack of vowel signs may result in ambiguity, primarily in the reading of words appearing in isolation (in the absence of context). Our question here is, what are the implications of this fact for literacy in Hebrew?

Until his death in 1988, Havelock continued vigorously to champion the view that real literacy in alphabetic writing was made possible only by means of the Greek alphabet, mainly because it supplemented the Phoenician writing system with a complete set of vowel letters. He believed not only that the Greek alphabet was superior to all previous types of writing, but also that it provided the first and “the sole instrument of full literacy to the present day” (1991, p. 26). Havelock maintained that Semitic writing that did not specify vowels was so ambiguous that it permitted only a limited type of reading, as well as a restricted convention of literature and literacy. He also argued that the texts afforded by pre-Greek Semitic writing (including the Hebrew Bible—the Old Testament) are only those consisting of well-known words and common sentence structures, and they tend to use a style that is “formulaic and repetitive.” In the Semitic texts, he continued, “the relationships between the characters are relatively simple and their acts take on an almost ritual quality” (1976, pp. 34–35).

Like other members of the Ontario group of social scientists, including Marshall McLuhan as their leader, Havelock believed that the “medium” was indeed “the message,” namely, writing systems affected the nature of literature and literacy. Semitic writing systems, he declared, were of standardized syntax and vocabulary, and their literacy was “craft literacy” as opposed to the “artistic” literacy evolving from Greek. With respect to specific writing systems, Havelock’s opinion of the Phoenician writing that preceded Greek was that it amounted to “commercial shorthand, but that was all” (1991, p. 15). Considering Hebrew, he held that the entire enterprise of Hebrew Mishna and Talmud as an exegetic literature interpreting Biblical law and all its ramifications “would not have arisen . . . had the original writings [he presumably meant the Hebrew Bible] had the advantage of transcription into the Greek alphabet” (1991, p. 17).

Havelock’s portrayal of Semitic literature and literacy is untenable. His characterization of Semitic literature ignores the whole array of Biblical and other Semitic literary genres. For example, the Pentateuch as well as the books of Joshua, Judges, Samuel, and Kings, contains far more prose than poetry. As for labeling it “craft literacy,” one can only feel pity for a scholar who cannot appreciate the beauty of one literary form without denouncing another.

More important, Havelock errs historically in attributing the invention of alphabetic vowel letters to the Greeks. As indicated earlier, vowel letters appear as early as in texts written in the alphabetic cuneiform of Ugarit (al-

though these vowel signs always appeared with the letter *aleph*)—centuries before the Greeks' adoption of Phoenician. As noted earlier, several vowel letters also appear in Hebrew texts, predating the Greeks' adoption of the alphabet. Although the signification of vowels was incomplete, the very fact that they existed means that the Greeks cannot be credited as sole inventors. Besides, the earliest Greek inscriptions were found in cities geographically closer to Phoenicia than to Greece, in Crete and Cyprus and at Al Mina (in today's Syria). The population in these areas was mixed, so we may never know who exactly deserves credit for providing more vowel signs in the Greek adoption of the Phoenician writing system.

Far from being "explosive technology" or "revolutionary" (Havelock, 1982, p. 6), the Greeks' contribution was that they perfected a device most likely adopted together with the rest of the alphabet. An interesting question is why the Semites themselves failed to produce a complete vowel system. I deal with this issue in discussing the psychological merit of vowels in reading (see chapter 3). My conclusion is that more vowels were not introduced because they were not really needed (cf. Sampson, 1985, ch. 5).

Now as to the exegetic motive behind the writing of the Mishna and Talmud, which, according to Havelock, arose from the need to interpret texts that were ambiguous due to the absence of vowel signs: Although I am not aware of a transcription (as opposed to translation) of the Hebrew Bible in Greek letters, there is, in fact, a very early translation of the Bible into Greek. This is the Septuagint, of the 2nd or 3rd century BCE, several centuries before the Mishna and the Talmud were committed to writing. For resolving ambiguities, a translation is even more useful than a transcription. At the time of the Mishna, many Jews spoke Greek and may have had access to this translation, even though they may have had no need for it. It seems reasonable that, among some Jewish families in Judea of that time, Biblical Hebrew was still passed down from father to son. So although the Mishna contains discussion about the correct interpretation of Biblical words, the entire project of the Mishna and the Talmud was not chiefly motivated by the aim of deciphering Biblical words as such. Had Havelock read the Mishna and the Talmud more carefully, he would have realized that these texts are not mainly about *how to read* the Hebrew words, but about how to follow what they meant.

My main concern here, however, is not to disclose Havelock's bias (this has been done by others: Bernal, 1987; Daniels, 1996) or to refute his claim. On a deeper level, I share Havelock's conviction that orthographies may make a difference in reading. And even though Havelock's main concern was the distinction among different families of writing systems, logograms, syllabaries, and alphabets, I am of the view that even across alphabets, linguistic and orthographic factors should be taken into account in the description of reading processes (see the book edited by Frost & Katz, 1992). In-

deed, my main argument against Havelock, and others who followed him uncritically, is that he misunderstood the processes involved in reading Hebrew (and other Semitic alphabets).

The basic principles guiding Havelock and others who hold a common-sense, yet oversimplified and erroneous view of reading Hebrew, may be briefly summarized (cf. Havelock, 1976, p. 23): (a) The representation of linguistic sounds conveyed by the signs of the writing system should be exhaustive. This system must be sufficient, in numbers of signs, to trigger the reader's memory of all the distinctive sounds of the language, so that guessing from context is not necessary; (b) The correspondence between signs and phonemes should be one-to-one, so that there is no room for making choices when readers attempt to recognize word sounds; and (c) The total number of writing signs must be limited in order to avoid overburdening the reader's memory. A number between 20 and 30 signs (letters) is the ideal.

Havelock's first principle must be severely compromised by his third one. If letters (or rather, graphemes) are to provide an exhaustive representation of the distinctive sounds of speech, their number must be many times more than 20 or 30. But phonemes are *categories of sounds*, not simply representations of distinct speech sounds. Consequently, our internal representation of phonemes is a product of abstraction or generalization. In addition, the way we process phonemes is dictated by the phonological context of the sound in question. Deciphering a word from a text involves more than the automatic association of graphic characters with speech sounds; other kinds of information must also be considered. This is not guesswork, but nor is it a simple association of visual signs, speech sounds, and meaning.

Recall too that no alphabet provides complete details of articulation. In the printed form of alphabets, tone, stress, length, and intonation are generally omitted despite their semantic and syntactic importance. These are filled in by the reader, who must go beyond the information given by the letters alone. This, in fact, is what today is termed the second direction of the reading process, namely top-down: using contextual knowledge to aid word decipherment.

Havelock's third principle regarding the limitations of memory when learning how to read is unfounded. Japanese children learning Kana and some Chinese characters, and Korean children who learn Hankul, memorize a much larger number of signs than exist in most alphabets; what is more, they are able to read them within the first month of school. This contrasts with an average of three months necessary to learn to read Hebrew and about six months to read English. According to Needham (1969), Chinese script, which consists of thousands of signs, was never an inhibiting factor in the development of modern science in China. In addition, Scribner and Cole (1981) found that the Vai people of African Mandingo learned to read their self-invented syllabary within several weeks, and the Cree syllabary could be

learned within a few days. Havelock seems to have tailored his principles to suit the writing system he cherished most, at the cost of devaluation of the writing systems he deemed unworthy.

On a deeper level of analysis, the issues here carry linguistic and psychological implications. The linguistic aspect includes synchronic and diachronic factors pertaining to the evolution of writing systems from pictograms to alphabets on the one hand, and the question of representation, or what exactly Semitic letters stand for, on the other. The psychological question concerns the type of information called for during the reading process. I consider each of these issues in turn.

The Linguistic Aspect: The Evolution of Writing Systems. On this point, Havelock fell prey to the approach proposed by Gelb (1952) regarding the evolution of writing systems. In his last chapter, Gelb advanced the theory that the different writing systems reviewed in his book can be placed on an evolutionary scale: "writing passed from one stage to another because at a certain time a new system was deemed better suited to local needs from one currently in use" (p. 236). Clearly, this is a Darwinian, survival-of-the-fittest, approach. But the question is, what makes one system more suitable than another? Gelb suggested several different criteria by which to assess the survival potential of writing systems. For example, he argued that what he viewed as the inferiority of the Chinese logography system is demonstrated by the fact that 90% of the Chinese population is illiterate. Concerning the reading of Arabic, he claimed that its disadvantage is rooted in a difficult orthography (difficult for whom?), and, of course, akin to Hebrew, it suffers from the absence of vowels in its writing system.

In favor of Greek writing, Gelb (1952) pointed out that it alone "created a full vowel system and thus offered to the world the potentiality of vowel indication, so important for the expression of exact nuances of language, little known dialectal forms, new words, and foreign names and words" (p. 238).

However, Gelb overlooked the fact that complete specification of vowels can be perfectly attained by syllabaries in those languages in which the syllabary is a linguistically appropriate option—where most words are monosyllabic or where words can be easily segmented into simple syllables, as in Japanese Kana or in ancient Akkadian. But once again, Gelb is trapped in his evolutionary theory of the development of writing systems, according to which a syllabary is, by definition, inferior to an alphabet.

In summarizing his views, Gelb asked: "Is writing progressing as it passes along the course of evolution marked by the logographic, syllabic, and alphabetic stages?" He answered: "I should say yes, it is progressing!" (1952, p. 239). He admitted that in some cases writing does not necessarily progress in a linear fashion, but we are given to understand that these are the exception, not the rule.

Generally, one would expect the powerful theory of evolution in the domain of literacy to be put to the test or extended to a variety of domains. Sure enough, Kalmar (1985) related an attempt by August Schleicher in 1869 to apply evolutionary theories to the development of languages. The rise of behaviorist psychology in the early 20th century may be seen as an extension of the survival theory along the behavioral dimension. The Chomskyan revolution can be regarded as an attempt to characterize the human faculty of language as providing an advantage over all other species; and Kuhn (1962) applied evolutionary principles to the development of scientific revolutions. For a century and a half, Darwinian evolution has always been at the back of many people's minds. But as Kalmar convincingly argued in respect of languages, evolutionary theory may not suit every domain.

The idea of evolution in writing systems has certainly been questioned on several grounds. Michalowski (1994) reported a study by a Russian anthropologist (Knorozov) who discovered phonemic ingredients in Mayan, a Mesoamerican writing system traditionally thought to be purely pictographic (or logographic) and therefore assumed to belong to the earliest stage of writing development. It is well documented that both Chinese and hieroglyphic Egyptian contain phonographic signs (cf. Gaur, 1984; DeFrancis, 1989). This implies that pure pictographies perhaps never existed as an adequate writing system, and that phonemic distinctions are indicated in every writing system. If so, this goes against the evolutionary theory of writing systems, in the manner suggested by Gelb.

Michalowski (1994) suggested that writing systems were genuinely invented only four times throughout history: in Sumer, in Egypt, in China, and in Mesoamerica. All other writing systems are derived in one way or another from these four through borrowing, adaptation, or other formative processes. The writing of Sumer, Michalowski proposed, was invented as a complete system. It never underwent a purely pictographic stage, nor did the rebus principle play any part in it, and, as mentioned earlier in regard to Mayan, it included phonetic elements from its beginning. From this perspective, neither the invention of the Semitic alphabet nor the addition of vowel signs by the Greeks constitutes a historic hallmark. These features all appear as gradual developments produced locally, different solutions being found in accordance with the nature of the different languages.

Michalowski criticized the argument as advocating "alphabetic supremacism." He noted the evident success of Chinese writing and its derivatives, and pointed out that for several centuries even after the Greeks had recourse to their alphabet, literacy in Greek was quite limited (cf. Harris, 1989; Powell, 1991). When literacy began to proliferate in Greek society, it was not because of the invention of additional vowels but because of societal changes that helped pave the way for Greek writers to create texts closer to the vernacular.

Social changes, not technological improvements, made Greek literature culturally significant.

Michalowski perhaps went too far in ignoring the role of orthography in literacy. For it is at least true that unlike syllabaries and alphabets, logographies, even those containing phonological signs, find it hard to incorporate novel words. Yet this does not necessarily mean an end to logographies. Logographies, such as Chinese, may be retained, but need to be supplemented with either syllabaries or alphabets. The lesson we learn from Japanese, Korean, and recent developments in China is that multiprinciple or hybrid writing systems combining signs for words, syllables, and/or phonemic signs, may benefit the users of at least some languages.

On different grounds, Kalmar (1985) reminded us that according to Darwin, evolution is not goal-oriented and not necessarily progressive. Rather, it is a product of natural selection among randomly produced variants (cf. Gould, 1977; Kalmar, 1985). So if writing systems develop according to evolutionary principles, we should expect the least fit ones to become extinct and the more adaptive ones to survive. True, some writing systems portrayed as “less fitted” by Gelb and Havelock (e.g., Egyptian, Mayan, Sumerian, and Phoenician) are no longer in use. But many other writing systems considered by Gelb and Havelock to suffer from the same shortcomings and prospective fate (e.g., Chinese, Japanese, Arabic, and Hebrew) continue to function. In fact, some of them are flourishing and none show signs of diminishing.

As for Hebrew, those like Gelb and Havelock who espoused the evolutionary approach, and believed that unpointed Hebrew is severely handicapped, are obliged to explain the endurance of this old system, hand in hand with the completely pointed (voweled) version, for the last 12 centuries. By Gelb’s and Havelock’s logic we should expect unvoweled Hebrew to have disappeared. But writing systems, it seems, are by no means “randomly produced variants.” More likely, each system was invented and crafted by creative problem-solving minds motivated by explicit goals—to facilitate communication via a fixed medium while preserving personal and cultural assets. The minds that invented writing systems were not unaware of the linguistic features and restrictions of the languages for which their writing systems were devised. In my understanding, there was nothing random about the formation of writing systems, quite the opposite; their invention was skillfully planned and wholly systematic. The products of these efforts were successful (though in need of various degrees of improvement), but they were a result of genuine human creativity and not an accident.

Insight is now being gained into how syllabaries and vowelless alphabets continue to function. Apparently, they contain feasible solutions for the reading and writing of the languages they came to serve. So rather than searching for a comprehensive evolutionary theory embracing all writing systems—an enterprise bound to gloss over language-writing relationships—we

ought to examine the means, functionality, and efficacy of different writing systems in serving their community along with the language of its readership.

The Representation Issue. What, then, do Semitic characters stand for exactly? On this point, both Gelb and Havelock seem confused. Recall that the origins of Semitic scripts (proto-Canaanite, Sinaitic) contained all the consonant signs but no signs for vowels. Gelb did recognize the similarity between early Semitic signs and Egyptian one-consonant phonograms; like the former, the Egyptian writing system failed to indicate vowels (but see Sass, 1988). However, in interpreting these facts, Gelb complicated matters by making an unwarranted inference. This was that if, indeed, the Semitic and Egyptian sets of one-consonant characters were interrelated, then “either they all represent alphabets, as is generally accepted, or syllabaries” (1952, p. 147).

There are several problems with Gelb’s reasoning. First, as noted, there seems no reason to reject the possibility that the Egyptian writing system contained a set of characters that functioned as an alphabet for specific purposes (e.g., writing foreign names).

Second, the Semitic alphabet, as long as it was strictly consonantal, was an exception among syllabaries and alphabets alike because most syllabaries, just like most modern alphabets, specify vowels. For this reason, even the classification of the Egyptian writing system as a syllabary is problematic because the very same sign may represent syllables that share consonants but not vowels. From this point of view, the classification of Semitic alphabets is equally plausible either as a vowelless (CV) syllabary or as a vowelless (consonantal) alphabet.

Like the question of the glass being half empty or half full, it all depends on one’s definition of an alphabet. Gelb and Havelock seemed to have difficulty with half-emptiness. They insisted that a genuine alphabet must have vowel signs. But other researchers believe that the Semitic consonantal alphabet meets the definition of an alphabet (e.g., Naveh, 1982; Sampson, 1985) because it contains signs that stand for single phonemes. The requirement that an alphabet must provide an indication for each and every phoneme of a given language is completely arbitrary. There may be several good reasons for accepting, perhaps even benefiting from, a vowelless alphabet, as I tried to show earlier. To sum up this point, Semitic letters stand for consonants pure and simple.

The Psychological Aspect: How Do Semitic Alphabets Operate? The basic premise of word recognition being mediated by word sound—as opposed to a process in which visual characters are directly associated with meaning—is now accepted by most researchers of reading (Frost, 1998; Perfetti, Zhang, & Berent, 1992). We have good reason to consider reading

in every kind of writing system, alphabetic or otherwise, as involving and often guided by phonological information. Our concern here is how this may be applied to the reading of alphabetic writing systems in general and to the reading of Hebrew in particular. The information contained in the unvoiced Semitic word is no doubt incomplete. But having to rely solely on consonantal information does not necessarily result in incomprehensibility.

First, as Havelock (1982) rightly ascertained, the reader can supply the vowels from memory. The real distinction here is between **bottom-up** and **top-down** processing. Bottom-up processing exacts initial information from the text in its overt form. It begins by identifying graphic signs and continues by processing information derived from them, from morphemes, words, and ever larger content units uncovered by a meaning-construction process. Obviously, vowel signs, if present, are considered in the initial stage.

Top-down processing in reading is initiated with a general notion of what the text is about. Elements in the text are then recognized and interpreted in light of the overall perspective. When words are completely unvoiced, the reader is likely to need more top-down processing in order to achieve correct reading. In practice, top-down processing is always involved in reading because even fully voiced texts do not provide information with regard to specific phonetic realization of the phonemes or intonation and other articulative specifications. Of course, top-down processing also provides a semantic context for the text being read, and, thereby facilitates resolution of all kinds of ambiguities, not only those involved in articulation.

Second, the extent of ambiguity found in contemporary unvoiced Hebrew texts is, in effect, quite limited. For one thing, vowel-letters indicate the vowels /i/, /o/, and /u/ in some of the words. More important, many Hebrew words are not at all ambiguous even when unvoiced. That is, the available consonant letters, together with the vowel letters, constitute a letter combination that almost always engenders just one interpretation (cf. Sampson, 1985, chapter 5).

In a sample of extracts from academic essays, literary texts, and newspapers (Shimron & Sivan, 1994), 77% of the words were not found to be ambiguous even when read in isolation. When placed in context, only a half of one percent of the words were found to be still ambiguous. It is likely that with additional context even those words would have been disambiguated.

Third, as shown in more detail in chapter 3, the informative value of consonant letters in unvoiced Hebrew words seems to be proportionally larger than that of the missing vowels. As I have indicated elsewhere (Shimron, 1993, 1997), vowels may facilitate the speed of reading but are not always necessary for the correct identification of words. Shorthand systems in many languages similarly omit vowels. Stenography is perhaps more difficult to read than normal text but much easier to write.

Thus, in spite of apparent auditory accessibility, vowels may not be as commonly represented in the phonological lexicon, and, to the extent that reading is mediated by speech sounds, vowels may be less important than consonants for recognizing printed words. As noted earlier, in a recent experimental study of visual word recognition (Berent & Perfetti, 1995), consonants and vowels were discovered to be decoded in two consecutive cycles. In very short exposures of words, consonants, on the whole, but not vowels, are successfully identified. Other evidence supporting separate processing of consonants and vowels is suggested by Lee, Rayner, and Pollatsek (2001).

Fourth, as described in more detail elsewhere (chapter 2 and 3), most Hebrew words consist of roots and patterns. The roots are vowelized differently and affixed in inflections and conjugations, but in most cases if vowels are ignored or not specified, the root letters, as a group, remain intact inside the whole word. Most roots have some common core meaning; that is, once the root is identified, some meaning of the word is readily apparent. In chapter 4, I reviewed a number of studies examining the hypothesis that in the process of reading the root is extracted from the rest of the word, that is, identified separately and eventually recognized for its core meaning. If this is indeed the case, the inventor of the Semitic alphabet deserves credit for not inserting vowel characters in the line of print. Inserting vowel-letters in the root would have rendered its identification more difficult because, unlike the invariant image of the root that appears intact in unvoweled writing, vowels vary quite frequently from word to word, and therefore are bound to hamper the recognition of the root.

Moreover, it is perhaps quite instructive that when comprehensive vowel signification was created to supplement unvoweled writing, vowel signs in both Hebrew and Arabic were added to words in the form of dots and strokes below and above consonant letters, as opposed to being inserted (intercalated) into their proper slots inside the root, so as not to tamper with the ultimate appearance of the word. The effect is that even in completely vowelized print of words, the root remains easily distinguishable and can be conveniently accessed in order to facilitate word comprehension.

If this is the case, it may not be too far off the mark to assume that the real reason why the Greeks inserted vowel letters into a Phoenician alphabet on a par with consonant letters was not only because of the importance of vowels necessary for the exact reading in general, but because, unlike Semitic languages, the Greek language does not have roots and patterns the way Semitic words do. Inserting written vowel letters into their appropriate slots between consonants would not impair word comprehension, as it might in Hebrew. There are, of course, other reasons specifically arising from the unique features of the Greek language. Sampson (1985) and Thomas (1992) suggested that, unlike the Phoenicians, who were able to comprehend

unvoweled words, the Greeks required vowel signs because (a) Greek has clusters of vowels in the middle of words (uncommon in Hebrew), and (b) because inflected case-endings in Greek often consist of vowels or end in vowels. Moreover, in Greek and other Indo-European languages, vowel signification is absolutely essential for semantic (meaning) and grammatical construction.

The upshot, again, is that the inventors of each writing system must be understood within the boundaries of a specific language, and it is within these boundaries that the efficiency of the writing system should be evaluated. It therefore may be comfortably concluded that literacy in Hebrew is certainly viable.

8

Perceptions and Evidence of Early Literacy in Hebrew¹

Hebrew is among the first alphabets to have been used intensely and extensively from the beginning of the first millennium BCE. The inception and development of the Canaanite alphabet as a unique writing system occurred in an area where writing was in fact a long-standing and well-established tradition. The cities of Canaan lay in the midst of (or near enough to) the traffic of goods, merchants, and armies among the superpowers of the time: Egypt to the southwest, Sumer and Babylon to the northeast. Under the influence of these powers, writing had already been used since 3100 BCE, a millennium and a half before the invention of the alphabet. In particular, those Hebrews who were in Egypt were bound to have observed the monumental writing of the Egyptians. In this way the metalanguage of literacy, and literacy as a state of mind, preceded and then accompanied the rise of alphabetic literacy. From this vantage point one may construe the invention of the alphabet as a local adaptation and simplification of well-known systems, as shown in chapter 6 on the Hebrew writing system.

The story of early literacy in Hebrew may be told on the basis of two sources: texts found at archaeological sites and Biblical documents. Each of these sources is somewhat problematic. As for archaeological evidence, the medium for most of the writing at that time was either papyrus or parchment. Unfortunately, except in very arid parts such as the Judean desert or

¹Parts of this chapter appear in a book in honor of Professor Ruth Berman (in preparation). In writing this chapter I was helped by several experts. Among them are Profs. Aaron Demsky and Terry Fenton. Mr. Murray Rosovsky and my daughter Yonat helped me in editing the chapter. I thank them all. Needless to say, the mistakes and misunderstandings are mine.

Egypt for that matter, papyrus and parchment could not survive the humid climate of the area. Indeed, a number of books mentioned in passing in the Bible did not survive.

Furthermore, our focus here is on early literacy among the Israelites, so with regard to archaeological or epigraphic findings, particularly those of the very early ages, it is not always clear whether a text was written in what is recognized today as Biblical Hebrew or in another Semitic dialect of the time.

With regard to Biblical documents, the Bible is not a history book. Many domains of daily life in the Biblical era are hardly mentioned, if at all. For example, the Bible tells us little about agriculture, administration, and education. The information culled from the text about these matters is incidental to religious issues. In addition, the historical validity of the stories should be subjected to particular scrutiny. Many of them are mythical or legendary, and some were passed down the generations orally for centuries before being put into writing.

In this chapter, however, my concern is not limited to the historical (factual) description. I am equally interested in the *perceptions* of early literacy, regardless of the historical validity of the stories told. I believe that even from Bible stories that seem to have no factual validity much can be learned about the views of the writers and their perception of what was believable in the context of their time. I start with a definition of literacy suggested by Olson (1991) and continue with observations about the perception and the evidence of literacy deriving from Biblical documents and archaeological exploration in the Biblical era.

Defining Literacy

Several questions arise that are pertinent to an evaluation of literacy in the context of a particular society at a particular time. Thomas (1992) succinctly put it thus: "We might define literacy as the ability to read and write, but read and write what?" (p. 8). One may add: reading by whom, and for what purpose? Also, what impact does reading have on the individual, the community, and the relationship between citizen and community?

Olson (1991) put forward a set of conditions he considered necessary for the development of literacy:

1. Texts must not only be written employing some type of fixing device, but also preserved and accumulated in an archival fashion so that communal texts may be accessed and the community of readers and writers may mutually benefit from each other's writing.
2. For literacy to have an effect, institutions, such as religion, law, science, government, schools, and literature, must make use of texts.

3. There must also be institutions inducting learners into those institutions, such as family, church, and schools. Inducting—or educating—institutions train children, as well as adults, to take roles in literate institutions or, at least, to understand the function of these institutions and cultivate attitudes toward them.
4. Finally, a metalanguage must also evolve, making possible discourse on texts and literacy.

These four conditions seem to have been defined with a well-developed literate society in mind. They are less suited to the initial stages of literacy development. In the earliest stages, fixing devices could be contrived: scratching a stone or a piece of pottery was perhaps the simplest. But archives take years to accumulate and institutions begin to benefit from literacy only after a sufficient proportion of their constituency and employees have become literate. For education to take place, there must be enough people able to teach literacy and enough students convinced that such a pursuit is worth their while.

Olson's conditions can apparently only be fulfilled through a process of gradual establishment of each condition and the eventual interaction of them all. An interactive view of literacy assumes a developing relationship among the individual, the language, the writing system, the community and its institutions, and the practice of literacy. The reciprocal stimulation must increase gradually, to promote the strength, and complexity, of each factor. For my purposes, I intend to examine early Hebrew literacy by referring to Olson's criteria when appropriate.

Early Perceptions of Literacy in the Bible

I would like to distinguish three perceptions of literacy in the Bible: (a) a mythical approach to texts, believed to be written by God or God's messenger (prophet); (b) literacy in the service of the administration (monarchy) of that time; and (c) modern literacy in the making. I dwell on a few examples of each of these, without attempting to exhaust the diverse references.

A Mythical Approach to the Text

The discussion here is strictly limited to a perception of literacy as reflected in the Biblical ethos. The analysis of the Biblical documents does not assume that the portrayed events actually happened. Clearly, most of them have a legendary (mythical) character.

The most prominent religious event in the Pentateuch, namely, the giving of the Ten Commandments to the Hebrews in the Sinai desert on their journey to the Promised Land, is ultimately a monumental event of public liter-

acy, involving, at one fell swoop, both writing and “un-writing” (breaking the tablets). As the Biblical story illustrates in unfolding this dramatic and mythical event, writing itself appears perfectly natural, and by no means a miracle. The metalanguage of literacy seems to have been embedded in the Israelite conception of religion and nationality from at least the time when this text was created and incorporated into the Israelites’ construction of their history.

Let us take a closer look at the confirmation of the covenant (Exodus 24).²

Moses wrote down all the words of the LORD, and built an altar at the foot of the mountain, and young men sacrificed peace offerings of oxen to the LORD. (4–5)

And Moses took half of the blood and put it in basins, and half of the blood he threw against the altar. Then he took the Book of the Covenant and read it in the hearing of the people. (6–7)

And Moses took the blood and threw it on the people and said, “Behold the blood of the covenant that the LORD has made with you in accordance with all these words.” (8)

The LORD said to Moses, “Come up to me on the mountain and wait there, that I may give you the tablets of stone, with the law and the commandment, which I have written for their instruction.” (12)

Note the relation between the *Book of the Covenant* (7), and the *blood of the covenant* (9), the two materials (auxiliaries) at the confirmation of the covenant. The blood, the most central entity of living, is used in this text to bind the people to the book and to the covenant, to create the unity of people, book, and covenant. God gives Moses the tablets of stone, the law (the Torah), and the commandments, as if glued together with blood.

In this text, the book is not just a medium on which the covenant is written for future remembering; it is inseparable from the law and the commandments—they are one. Moreover, as we see later in the text, this unity includes a physical touch of God:

And he gave to Moses, when he had finished speaking with him on Mount Sinai, the two tablets of the testimony, tablets of stone, written with the finger of God. (31:18)

²The English translation of the Bible passages cited in this chapter is the Standard English Version.

The tablets were the work of God, and the writing was the writing of God, engraved on the tablets. (32, 16)

Not surprisingly then, when God regrets making the covenant, its retraction is realized by the destruction of the book (tablets) of the covenant: breaking the tablets of stone. Finally, when the covenant was re-established, a new text has to be rewritten:

The LORD said to Moses, "Cut for yourself two tablets of stone like the first, and I will write on the tablets the words that were on the first tablets, which you broke." (34:1)

The renewal of the covenant is not realized until the book is rewritten:

And the LORD said to Moses, "Write these words, for in accordance with these words I have made a covenant with you and with Israel." (34:27)

We do not know when this text was created, but the mythical attitude to texts apparently continued throughout the entire Biblical era and after. As we see in the next sections, it appears vividly in the books of the three major prophets of the Hebrew Bible (the Old Testament).

Jeremiah's Scroll. The story is well known (Jeremiah 36). When Jeremiah is banned from going to the temple, he dictates a message to Baruch the son of Neriah, who reads it, written on a scroll, in the temple on a fast day. Then Baruch is asked to read the scroll to the officials in the king's house. When the officials report about the scroll to King Jehoiakim, he orders that the scroll be read to him. Having listened to three or four columns, the king cuts the scroll with a knife, and throws it into the fire on the hearth, until the entire scroll is consumed by the fire.

Here again, the king doesn't distinguish the message from the text and the medium (the scroll) on which it is written. As in the foregoing story of the tablets of stone, destroying the scroll is not a symbol. It is an act whose message itself is to dispel prophesies of doom. Not surprisingly, after the burning of the scroll, God tells Jeremiah to write it again, in a way reminiscent of the mythical nullifying of a contractual agreement—a covenant—and then re-writing it once again as with the book of the covenant at mount Sinai.

Ezekiel. A similar approach to literacy, albeit somewhat more imaginative, is evident in the beginning of the book of Ezekiel when he is called to assume the role of a prophet (ch. 2–3):

"But you, son of man, hear what I say to you. Be not rebellious like that rebellious house; open your mouth and eat what I give you." And when I looked,

behold, a hand was stretched out to me, and behold, a scroll of a book was in it. And he spread it before me. And it had writing on the front and on the back, and there were written on it words of lamentation and mourning and woe. (2:8–10)

And he said to me, “Son of man, eat whatever you find here. Eat this scroll, and go, speak to the house of Israel.” So I opened my mouth, and he gave me this scroll to eat. And he said to me, “Son of man, feed your belly with this scroll that I give you and fill your stomach with it.” Then I ate it, and it was in my mouth as sweet as honey. And he said to me, “Son of man, go to the house of Israel and speak with my words to them.” (3:1–4)

The call to Ezekiel and his personal confirmation as a prophet (messenger) are mediated by a scroll in a very special manner. In eating the scroll, the prophet Ezekiel internalizes the word of God. Again, there is no distinction between the message, the text, and the medium in which the message is recorded. The additional element here is the making of a person—the prophet Ezekiel—part and parcel of the text and the message.

At a later stage, God commands the prophet to eat the scroll, as if by consuming the scroll the prophet will internalize some divine power. The prophet is also asked to write down his prophecy (43:11–12) for the purpose of recording the future plan of the temple.

Isaiah. The prophet Isaiah tells how God commanded him thus: “Take a large tablet and write on it in common characters” (stylus of man) (8:1, 16). In this context, writing down God’s words seems to be an act of substantiating the message as well as underlining its nonephemeral nature. Later in the book the order is repeated: “And now, go, write it before them on a tablet and inscribe it in a book that it may be for the time to come as a witness forever” (30:8). Such an order was also given to the prophet Habakkuk (2:2). As with the Book of the Covenant, writing on stone was not just a matter of documenting the message: It eternalized the message, and incorporated it into the people’s reconstruction of their history.

* * *

In summary, these texts give the impression that at least in the eyes of those who edited the Bible, the three major prophets, Isaiah, Jeremiah, and Ezekiel, were committed to writing down some or all of their prophecies. Yet their writing was more than a communicative act. It signified their empowerment as messengers of God and their prophecies as the word of God. It also had the function of recording prophecies for future generations.

It seems likely that the major prophets could read and write, and their listeners were at least aware of the possibility of literacy and its inherent power.

It is also conceivable that at least some of the prophecies were written down from the outset and were originally conveyed in written—not just oral—form.

The mythical, religious, approach to the text as a sacred physical entity symbolizing special meanings and involving practical application has survived to the present day as an essential element of Jewish worship. Notable forms include the *tefillin* (phylacteries) and *mezuzah* (see below), as well as the manner in which the sacred books are treated in religious rituals. The origin of worship involving the *tefillin* and *mezuzah* is in Deuteronomy 6:

You shall love the LORD your God with all your heart and with all your soul and with all your might. And these words that I command you today shall be on your heart. You shall teach them diligently to your children, and shall talk of them when you sit in your house, and when you walk by the way, and when you lie down, and when you rise. You shall bind them as a sign on your hand, and they shall be as frontlets between your eyes. You shall write them on the doorposts of your house and on your gates. (6:5–9)

In contemporary Judaism the *tefillin* are a set of two small, black leather, cube-shaped cases containing texts written on parchment. In accordance with Deuteronomy 6:8 (and similar statements in Deuteronomy 11:18 and Exodus 13:9, 16) they are to be worn by adult Jewish males as a reminder of God and of the obligation to observe the Law in daily life. The *mezuzah* is a small folded or rolled parchment inscribed by a qualified scribe (in Hebrew, *sofer stam*) with scriptural verses (Deuteronomy 6:4–9, 11:13–21) to remind Jews of their obligations to God. The parchment is placed in a metal, wooden, or glass case, so the word *shaddai* (“Almighty”) on the back of the parchment can usually be seen. This case is attached to doorjamb in Jewish homes.

A plain, simple, interpretation of the Deuteronomy 6 passage cited (“You shall bind them as a sign on your hand, and they shall be as frontlets between your eyes. You shall write them on the doorposts of your house and on your gates . . .”) could (perhaps should) be understood to imply a total devotion to God and his words: We read, “And these words . . . shall be on your heart.” But the words came to be interpreted literally, and they still are. They have become the center of a daily ritual of observant Jews from the age of 13 years. Every morning they bind the *tefillin* on their left arm and forehead, and some Jews kiss the *mezuzah* whenever they enter a room or a building where it is attached to the post of a door or a gate. For them, the wording of God’s message and its inscription on the parchment are not symbols or metaphors—they are real sacred entities, in which the message and the medium in which it is written are indivisible.

The rituals around the *tefillin* and the *mezuzah* constitute a very special act relating to a kind of literary event. Here the texts of both the *tefillin* and the *mezuzah* are encapsulated in boxes, which are not to be opened, and conse-

quently are not directly read. So although the text is central in these rituals, the events as a whole are hardly literary events. True, an educated observer presumably knows by heart the message written in these texts inside the boxes. Moreover, the prayer, which accompanies the ritual of binding the *tefillin* on the arm and on the forehead, makes some reference to the texts inside. It cites one central phrase and mentions the common names of the four excerpts written on the parchment. Still, the text as a whole is not necessarily read. So just as we can think of literary events that convey meaning but do not involve a text (a lecture or a speech), we may take the rituals of the *tefillin* and the *mezuzah* as literary events devoid of reading, or any other direct exposition of the text and its meaning (cf. Goodman, 1994). To a certain extent, what is true for the *tefillin* and the *mezuzah* today is similar to the fate of the tablets, the Book of the Covenant according to the Biblical story: After it was placed in the ark, it was never to be looked at by the common people.

TOWARD A MODERN LITERACY

Recordkeeping

In modern literacy, all aspects of the literary event—the message, the text, and the medium that carries it—are crucial, but they maintain (at least some) independence. In many cases we are indifferent to the type of material on which the text is written or even to the exact wording. We see ideas and their implications as what matters most. For us today, literacy is mostly about expression and communication, which enable a literate person to acquire knowledge and to interact with others—people and institutions—so as to satisfy her or his needs in a literate society.

There is however a type of literacy, *record keeping*, in which the wording, and even the type of medium on which the record is kept, do matter, even in our modern society. Examples are the contracts we sign with regard to our property, or the record that determines our status or relationship with the bank, our employer, or our government (ID cards, passports, credit cards, etc.). These are relatively standard documents, with fixed phrasing and fixed forms; to be effective, they have to remain so.

An important difference between record keeping as opposed to expression and communication is that in the former only one side in the literary event need know how to read and write. A person may be listed in governmental records or even sign a contract without knowing how to read or write. Still, record keeping is essential for the orderly management of society, and it is in this sense that it was already practiced in ancient societies. Because the subject of the record is not required to be able to read and write, records could be kept even in eras when reading and writing were not yet widespread in the population.

In ancient Israel the administrative procedures of the Israelite monarchy underwent gradual formulation. The Bible rarely reports on these aspects of Israelite life, but fortunately for us such details are revealed in the concomitant details of biblical stories. An exemplary case is set forth in 1 Kings 21, the story of Naboth's vineyard. Jezebel, King Ahab's wife, plotted against Naboth, an Israelite citizen and owner of a vineyard near the king's palace in Samaria. King Ahab coveted the vineyard, and when Naboth refused to give it up on the grounds that it was inherited from his ancestors, Jezebel took the matter into her own hands and forged a letter to enable Ahab to annex the vineyard to his estate. Thus, the story goes, she wrote a letter (the Bible calls it "books") of accusation and blasphemy for treason, signed with the king's seal, and had delivered it to the elders of Jezreel, Naboth's city. The letters accused Naboth of cursing God and the king (and therefore Naboth deserved to die). As regards our concern with Biblical literacy, the story demonstrates how written correspondence and documentation were essential in the legal proceedings between the palace and the city elders sitting in the local court:

And Jezebel his wife said to him, "Do you now govern Israel? Arise and eat bread and let your heart be cheerful; I will give you the vineyard of Naboth the Jezreelite." So she wrote letters in Ahab's name and sealed them with his seal, and she sent the letters to the elders and the leaders who lived with Naboth in his city. (21:7-8)

Evidently, the Israelite monarchs of ancient times were not all powerful. To the extent that this story reflects a reality, which existed at least as early as the time when this story was written, it shows that keeping records in the Biblical monarchy was obligatory. Decisions were to be recorded in books and signed by authoritative figures. Even a message to the "elders," most likely a council or a court of justice, which had to approve the royal decisions, was customarily delivered as an official document.

Documenting decisions at the royal court was, of course, not the only reason for record keeping. A census for the purpose of taxation and army recruitment was then, as today, a crucial necessity of the regime, as documented, for example, in 2 Samuel 24 (see also 1 Kings 4):

So the king said to Joab, the commander of the army, who was with him, "Go through all the tribes of Israel, from Dan to Beersheba, and number the people, that I may know the number of the people." (2 Samuel 24:2)

We may never know the proportion of the population who could read and write in that era. Yet it seems likely that reading and writing as a form of record keeping were perceived as an everyday activity in the administrative circles.

Keeping a Record of Religious (and Judicial) Texts. In another story (2 Kings 22), King Josiah wished to renovate the temple in Jerusalem. To this end he sent Shafan, the scribe, to recover tax money collected by the priesthood for the temple's maintenance. In the process of renovation, Shafan was told by one of the priests about a book they had found in the temple, whereupon Shafan took the book and read it before the king. The book, *Sefer Habrit* (The Book of the Covenant), was subsequently read before the entire people of Israel.

A similar event occurs again later, after the return of the Jews from exile in Babylon (Nehemiah 8). On their return they gathered in Jerusalem for a public reading of the Torah ("the Book of Moses"). This occasion, however, went beyond a typical reading for it also included the social contract—*ketav amana*, a covenant reaffirming the community's commitment to the principles found in the Torah they had read, as well as certain appendages to the laws (Nehemiah 10:1). Thus the public reading, together with the writing of the covenant, became additional major literary events (Demskey, 1988).

The documents presented here do not indicate how extensive the spread of literacy was among the common citizenry of Israel (excluding professional scribes and the priesthood). It remains unclear whether the people had to be assembled for a public reading because common people could not read or because copies of the holy books could not be made available. In any event, everyone apparently knew what the books were for. The metalanguage of literacy, Olson's fourth condition, had already become deep-rooted in the pre-exilic period.

Literacy as Transporting Messages. One of the most typical uses of writing, according to Biblical narratives and pre-Biblical sources, was the transmission of messages. Reports from Egypt refer to letters borne and read aloud by messengers in the presence of a ruler (Widengren, 1948). As we have seen, the Bible describes such an event in reference to Baruch the scribe (Jeremiah 36), who delivered a written message by declaring its contents initially in the presence of the common people and then once again before the king. A detailed portrayal of another scribe's appearance is given in Ezekiel (9:2–3):

And behold, six men came from the direction of the upper gate, which faces north, each with his weapon for slaughter in his hand, and with them was a man clothed in linen, with a writing case at his waist. And they went in and stood beside the bronze altar. Now the glory of the God of Israel had gone up from the cherub on which it rested to the threshold of the house. And he called to the man clothed in linen, who had the writing case at his waist.

Here is a magnificent juxtaposition of the power of six men equipped with weapons of destruction, presumably armed with shields, and the one man simply clad in linen and whose only “weapon” is his ink-horn.

Recording Oral Traditions. As may be expected, writing gradually came to be employed for recording oral traditions. Biblical authors were in fact careful at times to quote their exact sources. For example, in Numbers (21), we find one of two poems relating to *Sefer milxamot Yahweh* (The Book of the Wars of Yahweh)—perhaps a book recording the wars of the Israelites. Another ancient book, *Sefer hayashar*, probably also a collection of oral traditions, is quoted on several occasions (e.g., 2 Samuel 1:18; Joshua 10:13; 2 Kings 8:53). Not one of these books has been discovered, suggesting that all succumbed to climatic conditions. However, the references to these books almost certainly imply that in Biblical times they were not only known but were accessible. A reference makes sense only when it can be verified and validated. This is the context in which the discovery of the book in the temple in the time of Josiah should be considered.

Incidental Mentions of Writing in the Bible. In view of the massive loss of the main sources of literacy (see above), that is, sources written on perishable materials, our only alternative is the analysis of Biblical texts. The Biblical story of Joshua and the Judges in the early stages of Israelite settlement is replete with incidental references to writing events, thereby attesting that writing was by no means a novel or unusual occupation, at least at the time of compilation of the Hebrew Bible. For example, in dividing the Promised Land among the tribes, Joshua commands their representatives to write down seven parts of the country in preparation for a lottery that was to determine the rules of division (Josh. 18:7–9). In the song of Deborah (Jud. 5), the tribe of Zebulun is characterized as one renowned for its scribes. A few chapters later, the judge Gideon seizes a young man and orders him to write down the names of the officers of the city of Succoth (Jud. 8:14). As it is unlikely that all young men of this time could read and write, perhaps he was a scribe’s apprentice. But the important testimony of this story is that writing was already established in the administrative procedures of the kings of Canaan (Demskey, 1977). This testimony should satisfy Olson’s second condition regarding the institutionalization of literacy.

Existing evidence of the congenital ties between writing and delivering letters perhaps resides in the common Hebrew root KTV found in the words *ketav* (writing) and *mixtav* (letter as a written message). These ties may also be indicated by the polysemy of the word “letter” in Greek and via Latin in modern European languages such as English, sharing the dual meaning of a written character and a written message.

Archaeological Evidence of Early Literacy in Hebrew

The first findings of manifestly Hebrew texts, as opposed to writings in other Semitic dialects—evidence of full-scale literacy—are believed to be from the 8th century BCE, during the First Temple period. These were papyri discovered in a cave in the Judean Desert together with more than 20 pieces of clay that served as seals for the papyrus scrolls. Now it seems quite certain that only a paltry number of texts remain from the first 400 years of Israeli settlement in Canaan because most of the writing was done on papyrus, which could not withstand the climate of the central and northern parts of the land.

As noted elsewhere, the Israelites did not erect monuments in the name of kings or God, and indeed, most Hebrew writing of the time was cursive rather than lapidary, even when incisions were made on hard material. When texts eventually did begin to appear in abundance, a great many of them (such as the collection of letters found in Arad and Lachish) were written in ink on shards—a method of inscription commonly known as *ostraca* (singular *ostrakon*).

The archaeological evidence of literacy may be classified into several types. Among them are: *domestic writing*, practiced by literate citizens (not necessarily scribes), *educational materials* for cultivating professional scribes, *correspondence* conducted by scribes in the service of rulers, *belles-lettres* such as poetry, and seals.

Domestic Literacy

Within “domestic literacy” I include documents written by the inhabitants of Canaan unearthed in archaeological excavations. Typically these were written at home for personal or family purposes. The content in many instances concerns practicalities, such as stock-taking, marking property for protection, devoting gifts to gods, and perhaps even compliance with a religious commandment, such as inscribing texts on house entrances (Deut. 6:9; cited earlier). Occasionally, people were also interested in transmitting messages by a fixed medium to remote destinations.

A marvelous example of this kind of literacy was discovered by Meshel (1978) in a tiny settlement, Kuntillet Ajrud, between the Negev desert and the Sinai peninsula, dating to the First Israelite Temple in the early part of the first millennium BCE. The entire settlement consisted of just two buildings, of which the larger measured 25 × 15 meters. In this building the floor, the walls, and some benches were covered with shiny white plaster. Parts of the walls had been painted and written on. Surprisingly, among the plaster debris on the floor were fragments of inscriptions in Phoenician letters writ-

ten in ink on plaster. In addition, inscriptions bearing names were found on two large pithoi (pots used for storing wine or grain). Inscriptions in various colors of ink were also found near the entrance to the rooms, apparently written on the doorjambs, reminiscent of the Biblical verse: “And you shall write them on the door-posts of your house and on your gates” (Deut. 6:9). However, it cannot be determined whether they correspond with the Biblical injunction.

This evidence in itself does not reveal much about the general literacy of this era, but at the very least it corroborates and therefore lends additional credence to technological details with regard to writing as depicted in the Bible:

And on the day you cross over the Jordan to the land that the LORD your God is giving you, you shall set up large stones and plaster them with plaster. And you shall write on them all the words of this law . . . (Deut. 27:2–3)

Demsky (1988) submitted that this practice of writing at home might have been more widespread in ancient Israel, which would explain the paucity of monumental inscriptions chiseled in stone (p. 17). Yet there may be other reasons for the absence of inscribed stone monuments in ancient Israel. The propensity for domestic literature may have combined with reservations about public monuments as noted, reflecting the nomadic tribal nature of ancient Israel and the resistance (or at least ambivalent attitude) to central government and the institution of monarchy (cf. 1 Samuel 8).

Meshel (1978) sorted the signs of literacy from Kuntillet Ajrud into several categories:

1. Single letters incised on pottery before firing, probably written to identify their contents; for example, the letter *qof* to mark “*qorban*” (sacrifice), or the letter *tav* to mark “*truma*” (offering).
2. Inscriptions in early Hebrew script incised on pottery after firing, signifying the names of people who owned the jars or people to whom the jars were delivered (e.g., the governor of the city).
3. Inscriptions in early Hebrew script incised on stone vessels. One of these was imprinted with the following sentence (translated from Hebrew): “To Obadia son of Adnah. May he be blessed by God.”
4. Inscriptions written in Phoenician characters on plaster, some of them probably coming off the doorjambs that contained texts of blessings (see above).
5. Perhaps the most important find in our quest for the earliest Hebrew literacy is inscriptions accompanied by drawings on pottery vessels. Among them are three abecedaries—lists of the letters of the alphabet—from the ninth letter to the end, in almost the same traditional order that became typical of all Semitic alphabets (and to some extent

Greek and Latin). The find of these abecedaries is particularly important for literacy research because they are an indication that even in this remote settlement a degree of literacy was imparted: Perhaps the abecedary shards were the homework of a young pupil.

The entire collection of early domestic Semitic writings uncovered by archaeologists obviously cannot be reviewed in this chapter. The interested reader is referred to Cross (1967), Demsky (1997), Naveh (1982), Pritchard (1955), Sass (1988), and Na'aman (2002).

Belles-Lettres

The ink inscriptions on plaster discovered in Deir 'Alla in the Jordan Valley (7th or 8th century BCE) and containing a poetic text attributed to the biblical figure Balaam Ben Beor (Numbers 22–24) suggest early attempts at committing oral literacy to some form of “hard copy.” The language of the text could be understood by Israelites as well as by Moabites and Ammonites. There are clear links with the Biblical Balaam story. Levine (1985) concluded, “contacts across the Jordan, in both directions, were normal throughout the tenth to the late eighth century BCE, allowing for continuous cultural interaction” (p. 338). Some of the two-way literary traffic over the Jordan River may well have been conducted in writing. Presumably, whoever wrote the Deir 'Alla text on plaster might just as easily have written it on a more portable (yet perishable) medium. To the extent that reading materials existed and were accessible, enough members of the Hebrew-speaking community could undoubtedly read them and generally participate in literary exchange.

Literacy Education

Is there evidence in Biblical texts for the existence of formal literacy education, Olson's third requirement? The Bible, as we have said, is not a history book. If history is told in the Bible it is to serve a purpose beyond the mere recording of historical facts. So to answer this question one has to recover from the Biblical text incidental notes or references on which a historical background may be reconstructed. One such reference that may be conceived as evidence for the existence of formal schooling in the pre-exilic period is the following complaint made by the disciples of the prophet Elisha (2 Kings, 6, 1): “the place where we sit before you is too small for us.” Although these were novitiates for prophecy, and not for the office of scribe, it is reasonable to conclude that schooling of some sort took place.

Another possible complaint of perhaps a student scribe may have been preserved in the book of Isaiah (50:4–11). The question of course is who

authored this text. But whoever he was, he clearly enjoyed and appreciated daily learning; whether he was also engaged in reading and writing, or was associated with systematic learning, is hard to tell:

The Lord GOD has given me the tongue of those who are taught, that I may know how to sustain with a word him who is weary. Morning by morning he awakens; he awakens my ear to hear as those who are taught. The Lord GOD has opened my ear, and I was not rebellious; I turned not backward. I gave my back to those who strike, and my cheeks to those who pull out the beard; I hid not my face from disgrace and spitting. But the Lord GOD helps me; therefore I have not been disgraced; therefore I have set my face like a flint, and I know that I shall not be put to shame.

Were there professional teachers? In Proverbs 5:13 a student expresses his remorse: “Neither have I hearkened to the voice of my teachers, nor inclined mine ear to those who instructed me”; and in Psalms 119:99 the Psalmist says: “I have learned from all my teachers.”

Did students pay tuition? The literal meaning of the Hebrew verb for “*getting* knowledge” (or wisdom) in a famous phrase from Proverbs (4:7; 17:16) is QNH, meaning “to buy” (i.e., to buy wisdom). Although most English translations have “get” instead of “buy,” we must tread carefully because all other uses of the verb QNH in the Bible are consistent with what is today meant by buying: a transaction in which money changes hands (e.g., Gen. 23:18; 25:10). If the literal translation is valid (a possibility supported by Prov. 23:23), it means that at least in some circumstances teachers were remunerated.

When trying to account for the meager number of Biblical references to formal schooling, one wonders whether schooling was so uncommon, or so prevalent, that it demanded no particular mention. Appraising the evidence presented here and comparative evidence from neighboring regions, Davies (1995) concluded: “. . .persuasive indirect arguments can be built up for the existence of schools in ancient Israel, and these arguments also imply that such schools would have been, at least in part, associated with the training of government officials” (p. 204).

Among other scholars, Lemaire (1981; cf. Crenshaw, 1998) listed 11 types of evidence for the existence of schools in the Biblical era. He asserts that literacy education in ancient Israel during the 8th century BCE expanded to such an extent that by the end of the monarchy it had spread to outlying villages, so that reading and writing were in the possession of common people. Shards (ostraca) were probably their preferred mode of writing material. Papyrus and leather were more often used by the administration, the priests, and the prophets. It is quite likely that sacred texts were copied in these schools; probably in this manner, rather than by oral transmission, Hebrew tradition was preserved and conveyed from generation to generation. There

may have been varied traditions in literacy education, namely, royal as opposed to clerical schools, but it seems that all these schools were ultimately responsible for the canonization of Biblical texts.

Abecedary. The clearest evidence of learning to read and write is students practicing systematic writing of the alphabet in a fixed order. The English term for a list of letters, more or less ordered in a fixed manner and written on some available material, is *abecedary*, derived from the names of the four first letters of the Latin alphabet. The first examples of abecedaries were found in Ugarit in northern Syria. They date to the 14th century BCE. Interestingly, although the letter order in the alphabet was apparently determined at least as early as the 14th century, the direction of writing was not resolved until some centuries later. For example, the abecedary found in Izbet Sartah (east of Rosh Ha-Ayin in Israel) was scribed on a shard apparently in the 12th century BCE (era of the Judges) (see Fig. 8.1). Some consider it the earliest evidence of alphabetic literacy (Demskey, 1977, p. 52). It contains a complete set of 22 letters, in almost conventional order, and is written, like the earlier Ugaritic abecedaries, from left to right, contrary to the later Hebrew (Kochavi & Demskey, 1978).

The spread of abecedaries from Syria in the north to the Negev in the south is in itself remarkable. In addition to Ugarit and Izbet Sartah, such texts were also found in Gezer, Lachish, Kuntillet Ajrud, Kadesh Barne'a, Qumran, and Shiqmonah. Abecedaries were also found on seals whose original source and location are unknown (see Carmon, 1972; Sass, 1993).

Special Training in the Cuneiform Tradition. Additional evidence indicating the systematic training of scribes in the cuneiform tradition may be



FIG. 8.1. A proto-Canaanite abecedary from Izbet Sartah (east of Rosh Ha-Ayin in Israel) was scribed on a shard apparently in the 12th century BCE (era of the Judges). It contains more than 80 letters in five lines, written by a novice pupil.

gleaned from lists of international vocabularies and exercises found in Gezer, Ta'anak, and Shechem (central Israel). A trilingual word list, perhaps used as a dictionary, was found in Aphek in a cuneiform writing. In all likelihood, these were lists of terms, probably of Babylonian origin, employed in international correspondence and whose use was continued in later periods. Learning these terms seems to have been part and parcel of scribal education (Demskey, 1990).

Observing the entire bulk of findings in Syria and Canaan, written in cuneiform, Demskey (1990) concluded that there is enough evidence to indicate that as early as the 2nd millennium BCE a cadre of local scribes in Canaan maintained the Mesopotamian (Babylonian) scribal tradition traced back to the 18th century BCE. Demskey argued that the evidence points to the existence of several scribal centers. He mentions Hazor, Meggido, and Aphek as possible sites for such centers. There is, in fact, ample testimony that Hazor (in northern Israel) maintained strong commercial ties with cities in northern Syria and Babylon itself. The aforementioned 13th century trilingual dictionary was apparently compiled to facilitate the work of scribes who corresponded with remote countries. Letters found in El-Amarna in Egypt contained cuneiform letters that indicate correspondence with major Canaanite cities such as Jerusalem, Shechem, Lachish, Gezer, Akko, Ashkelon, Hazor, and Meggido. In addition to the Babylonian influence, some of the El-Amarna letters reflect an Egyptian tradition whereas others represent a more local, Syrian legacy. The findings mentioned in this section suggest that alphabetic writing tradition and schools had taken root in an area where a limited scribal class already existed. These were channels of higher culture that influenced early alphabetic training.

There is very meager evidence about the education of the scribes in the Biblical era. One possible find that perhaps indicates a scribal schooling is a letter written on a tablet in cuneiform, found in Tel Balata, ancient Shechem, in 1926. The letter is dated to the 14th century BCE and reflects a Mesopotamian tradition in Canaanite life of the time; it has several interpretations and the identity of the writer is debated. One of these interpretations prompted Albright (1942), who was recently supported by Demskey (1990), to explain it as a letter from a teacher to a nobleman, named Birashenna, living in Shechem, requesting rations as payment for instruction.

Therefore, even though there is not much archaeological evidence for a "school" as we know it from later periods (despite some indications in the Biblical text: see above), one may still elicit from epigraphic documents the breadth of a local scribe's education in the second millennium BCE. Evidently, many scribes were proficient in more than one language. In fact, the trilingual text found in Aphek shows that some scribes had considerable mastery of more than two languages. In addition to writing skills in their local tongue, scribes apparently also knew Akkadian, the *lingua franca* of governments of the time in this region. Investigation of the writing quality of El



FIG. 8.2. Two personal seals. The right one contains an icon of a bird. The text says: lyozniahu eved hamelex 'to yoznyaho servant of the king.' The second (on the left) contains no icon. It says: lgdlyhu evd hmlx 'to gdalyahu servant of the king.'

Amarna scribes indicated Akkadian as their second language. Egyptian scribes knew at least Canaanite and the Babylonian dialect of Akkadian.

Seals. The account of archaeological evidence unearthed from the 8th century BCE onward, relating to popular literacy in ancient Israel, should include the excavated finds of an enormous number of personal seals, of which a great number contained texts. Sass (1993) reported that out of the total 1,500 west Semitic stamp seals he documented, the number of Hebrew seals approached 700. Of these, close to 500 are aniconic—just containing some form of writing, and 370 of these bear merely two lines of script. Sass suggested that this high proportion of Hebrew-written seals motivated the more talented seal-cutters to pay greater attention to Hebrew calligraphy. The attempt to avoid iconographs in Hebrew seals (see Avigad, 1986, and some reservations in Sass, 1993) may indicate that seal engravings in Israel did, in effect, conform to the prohibition against making idols, as ordained in the second of the Ten Commandments (Ex. 20:4; Deut. 5:8). Alternatively, as suggested to me by Demsky (personal communication, 2003) the larger number of aniconic seals indicates a higher level of literacy of seal engravers and readers (see Fig. 8.2).

Who Wrote?

An important question in this regard is who could read and write in this era? The Bible tells us about scribes (*sofrim*) who were without doubt professional writers; many of them were directly employed by the royal court for general record keeping or for serving the king in jobs that required reading and writing. In this capacity they were also known as secretaries (*mazkirim*) (cf. 2 Samuel 8:17; 1 Kings 4:3; 2 Kings 18:18). Some were probably employed by the clergy for making copies of sacred books such as the one found by Josiah (2 Kings 22), and some may have worked in the service of citizens.

It seems likely that the Canaanite, and later on the Israelite scribes, inherited at least some of the traditional privileged status of the scribes in Mesopotamia and Egypt. They were not only able to fill positions that required their expert literacy as teachers and mentors or in serving the administration and the clergy. They also formed a special elite minority group before whom the doors of knowledge—knowledge of foreign texts, and knowledge of the emergent sciences such as mathematics—were opened. Many of them had to know several languages, and writing systems, and thus held important keys to the cultural progress of their community. Evidence of their elitist outlook is exposed in a composition found in Egypt known as “In Praise of Learned Scribes”:

Be a scribe, put in it your heart that thy name may fare similarly. More effective is a book than a decorated tombstone or an established tomb wall. . . . It is better than a (well-) founded castle or a stela in a temple.” (Pritchard, 1955, pp. 431–432)

As I understand it, this is not overweening arrogance; it is a sober, even critical, view of one’s worth for the advancement of culture in one’s society. Another statement in praise of the scribe from a much later period appears in the treatise of Ben Sira (38. 24–39. 11), believed to be composed in about 180 BCE.

But the point also at issue here is whether the literacy of that time was limited to a few professionals. If this were the case, one would expect that in densely populated areas residents would routinely enjoy and perhaps rely on the services of a number of professional writers. But this assumption would then lead one to ask what a professional writer would be doing in such a small and remote place like Kuntillet Ajrud (see earlier). Presumably, no professional scribe could make a living serving the very small community there. It appears, therefore, that literacy during the era of the Judges and the Israelite monarchy was widespread throughout the country. The variety of literary practices seems *not* to have been entirely in the hands of the scribes. Moreover, writing was evidently practiced for more than strictly administrative and religious purposes, such as the writing on doorjambs. As mentioned previously, it was also employed for more private and mundane needs such as marking ownership and transcribing dedications. For some portion of the population it certainly satisfied the kind of intellectual, emotional, and aesthetic needs that we derive from reading today. It must have been so, because where there were texts of the kind we know existed in this area, there must have been readers.

As many experts on the development of the alphabet suggest, the invention of the alphabet created the possibility for increasing literacy among the

common people. We may not appreciate enough the huge leap in cultural development that became possible with the invention of the alphabet.

Summary

Millard (1985) reviewed the entire collection of early writings from the Biblical era discovered by archaeologists in ancient Israel. He cited a total of 39 locations (the number has probably grown since), and plotted the distribution of archaeological sites where evidence of writing was found. The sites extended broadly from the Mediterranean Sea to the Jordan River in the east, and from the mountains bordering Syria, in the north, to the central Negev and still farther south toward Elat. Observing this entire array of findings, Millard noted, as indicated earlier with regard to Kuntillet Ajrud, that although scribes were undoubtedly responsible for the majority of Hebrew texts written in Biblical times, the content of epigraphic material found throughout Israel makes it hard to imagine that any one scribe could possibly take the trouble to make journeys, lengthy by ancient standards, in order to write notes of purely local and ephemeral interest. If scribes refrained from traveling extensively to offer their services, this further endorses the supposition that local military or government employees, or even private citizens, were capable of writing during the First Temple era.

Furthermore, one may assume, as Millard proposed, that “where there was writing there was certainly the possibility of literature, and of reading of it” (1985, p. 307). Of course, the question also arises in reference to what kind of literature existed or was available to the readers of that time. This is a thorny problem to solve because, again, an unknown number of scripts written on papyrus, parchment, or wood no doubt failed to survive the humid climate of central and northern Israel. We may infer the existence of such writings from the prodigious number of scripts found in the Judean desert, where humidity is extremely low.

Regarding techniques of writing, Millard suggested that scripts written in ink might be attributed to those experts who possessed the appropriate knowledge and equipment, whereas writings done by scratching or pecking on pots might have been produced by anyone who knew how to shape letters. Some of these writings actually look like the work of schoolboys, artisans, or laborers. Aside from scripts written in major cities, the remaining material could have been written by anyone. These considerations combine to make “a strong case for writing as a well-known phenomenon during the monarchy” (1985, p. 305).

Finally, as I indicated in various previous sections, the picture portrayed by the epigraphic findings in Israel is liable to be severely distorted. With the exception of findings from the Judean desert, most of the extant epigraphy is inscribed on hard materials such as shards, metal, stone, and plaster. Shards

then were like scrap paper today, that is, used for jotting down immediate mundane matters, practicing writing, and so on. Important books, namely those documenting traditions of oral literature or chronicling governmental records, were written on parchment or papyrus—fixed media with a very short life span in a humid climate.

In a careful analysis of both archaeological findings and Biblical texts, Haran (1983) demonstrated that with some exceptions the main form of writing in Biblical times was on papyrus scroll. Although papyrus materials could not survive the climate in Israel, traces and remnants of papyri from the pre-exile period have been found in a number of places in this land (Haran, 1983, p. 165). Evidently, papyrus was readily available to Canaanite writers. There is evidence, beginning from the 12th century BCE, of export of papyri from Egypt to the city of Gebal (Byblos) in Lebanon. It was from there that the Greeks received papyrus. They called this city Byblos, from which the Greek word *biblion* “book” was derived. Interestingly, the word Bible “The Book” thus was etymologically associated with papyrus; yet a fair amount of evidence shows that the Biblical texts themselves, as an exception to the rule, were copied onto parchment. This was certainly the case during the Roman age in Palestine as confirmed by the findings of the Dead Sea scrolls, as well as Mishnaic and Talmudic literature (e.g., *Megilah Yer.* 71d).

With regard to the criteria of literacy as suggested by Olson (1991), presented earlier in this chapter, we have already noted that the metalanguage of literacy is deeply rooted in the biblical story. Reading and writing assumed different roles but they were part and parcel of every major event from the delivery of the Ten Commandments to the gathering of the people upon returning from exile in the days of Ezra and Nehemiah. As for the existence of archives, there is no direct evidence of them, but from the stories about Naboth and the sacred book found by Shafan in Jerusalem, it appears that both the clerical establishment and the administration kept records and stored documents and books. The abecedaries found in many sites in Canaan suggest that some forms of literacy education were in existence as early as the time of the first temple. How exactly the responsibility for literacy education was shared between the family and other institutions is not clear. But the collections of letters found in Arad and Lachish, and the seals of papyrus scrolls found in the Judean Desert, seem to attest that literacy in Hebrew was widespread in early ages, relatively not too long after the invention of the alphabet.

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Glossary

Note: A word printed in upper case is discussed in this glossary as a separate item.

Affix. Sublexical element of a complex word such as the *-ed* in *walk-ed* or the *re-* in *re-done*. Affixes cannot appear as independent words so they should be considered as bound MORPHEMES. They may be attached to the beginning, the end, or even inside the word base. A distinction is made between inflectional and derivational affixes. Attaching the first type to a base word does not change the word class (e.g., *walk* and *walk-ed* are both verbs). Attaching the second type does change the word class (e.g., *walk* and *walk-er*—the first word is a verb, the second is a noun). Modern Hebrew also has inflectional and derivational affixes in both the verbal and the nominal word groups. In the verb *hit-labaš-ti*, ‘I have dressed’ the prefix *hit-* is derivational, as it defines a special subgroup of words—the inflection class of *hitpa’el*. The suffix *-ti* is inflectional, as it marks the verb as 1st person, singular, past tense. In the nominal group, *-im* in *masmer-im* (nails) is inflectional as it marks the plural; *-on* in *masmer-on* ‘small nail’ is derivational, as it defines a novel noun.

Aspects. Grammatical aspects are temporal markers of verbs that mark the duration or the type of temporal activity denoted by the verb. A major distinction of aspects is between *perfective* and *imperfective*. The first marks verbs that denote a completed action; the second marks verbs denoting continuous action. Aspect hardly exists in Modern Hebrew, but it is intensively used as a temporal marking system in Biblical Hebrew. The mark of the Biblical perfective is the prefix *va* affixed to a future verb form, for example, *va-yomer* ‘he has said’.

Base. The base as defined in this book is the main MORPHEME of a complex word, to which affixes are sometimes attached. Normally, the base is a word in its own right. For example, in the words *šir-im* ‘songs’ and *ya-šir-u* ‘they will sing’, the base is *šir* ‘song’.

Bottom-up processing. The direction of perceptual information processing aimed at identifying an object. Bottom-up processing in reading or listening begins the identification by exacting elementary information from the text’s orthography (letters, syllables, MORPHEMES). Next it combines these elemental units to larger ones, on the way to deciphering larger and meaningful units such as words and sentences.

Case. Grammatical cases are morphological structures (present in some languages to different degrees—from zero cases to more than ten) by which word classes are sorted according to their syntactic relationships to other words in the sentence. For example, *nominative* marks the sentence’s subject, *accusative* marks the sentence’s object, *genitive* indicates possession. *Directives* indicate the nouns’ spatial goal. In general, Hebrew did not preserve case markers. The only remnant is the directives, marked by the suffix *-a*, which appear in archaic Hebrew texts and signify toward a location. For example, ‘he went to Jerusalem’ may be phrased as *hu halax yerushalaym-a*.

Categorical (Semantic) Decision. An experimental task designed to assess the complexity or difficulty of reading a word based on the assumption that reading complexity is correlated with the time of reading and the number of errors made. In this task the reader is shown a list of words one at a time, and is required to decide if the word belongs to a certain category (e.g., flowers or clothes). The category is announced prior to the presentation of the target stimuli. Some of the stimuli fit the category, others do not. The reader marks his or her decision by pressing one of two buttons, a Yes button marks a positive answer: the stimulus belongs to the specified category, a No button marks a negative answer: the stimulus does not belong to the specified category. The time elapsed from the onset of the stimulus to the pressing of one of the buttons, and the correctness of the response, are recorded and serve as measures of reading complexity.

This task requires complete word recognition and comprehension, and is not interrupted by articulation processes. However, the decision process itself is not part of real-life reading.

Default procedure. In the context of morphological processing, a default procedure is defined as automatic production of inflections and derivations in a lawful manner, according to what are traditionally considered grammatical rules, for example, attaching the proper plural suffix to Hebrew (and English) nouns. Different defaults may exist in different word groups or sub-

groups. For example, number inflection of masculine and feminine Hebrew nouns have different defaults.

Dual route theory of word recognition. This theory in its present form assumes that in the complex process of recognizing and comprehending a word, at least two major processes are at work. One process directly associates the visual appearance of the word as a whole with the representation of the word in the (orthographic) mental lexicon, then, due to the links between the orthographic, phonological, and semantic stores, the word is understood and may be articulated. A second (indirect) process begins by associating the word's graphemes (letters and letter clusters) with their phonological counterparts in the mental lexicon. Then, due to the similarity between the assembled phonemic information and the spoken word, and owing to the already established link between the sound of the word and its meaning, the word is recognized and comprehended. The direct route must be assumed because the assembled phonological information never approaches a complete representation of the spoken word. Some information (in every writing system) must be gleaned from our knowledge of the word as a whole. That is particularly true in languages of complicated representation of the spoken words in their writing system. The indirect route must be assumed in view of our ability to pronounce novel and nonce words, as well as evidence showing an association between phonological knowledge and speech difficulties on the one hand and reading difficulties on the other hand. There is also accumulated evidence indicating that phonological processing is performed rapidly automatically, and immediately following the visual identification of the print. A leading theory in the psychology of reading suggests that the two processes operate simultaneously and interactively, feeding and supporting each other.

Gaze duration. A measure of the total length of time that the eyes have been fixed on a particular spot in the text (normally a word). The length of time is the sum of one or more fixations. The measure is employed by researchers who believe that gaze duration is correlated with the complexity of word recognition and comprehension.

Lexical Decision. An experimental task designed to assess the complexity or difficulty of reading a word, based on the assumption that reading complexity is correlated with the time of reading and the number of errors. In this task the reader is presented with a list of words and NONWORDS, known as *stimuli*. The stimuli are presented one at a time. The reader's task is to decide as fast as possible, and without errors, if the stimulus presented is a word or not. Usually the reader marks his or her decision by pressing one of two buttons, a Yes button marks a positive answer: the stimulus is a word, and a No button marks a negative answer: the stimulus is not a word. The

time elapsed from the onset of the stimulus to the pressing of one of the buttons, and the correctness of the response, are recorded and used as measures of reading complexity.

Word recognition is assessed in this task without the interference of articulation processes. However, the response in this task does not require word comprehension or even complete orthographic identification. In some cases a Yes or a No response can be made on the basis of partial orthographic information. Some researchers believe that the lexical decision task relies on a search in the mental lexicon for the whole word (sometimes referred to as “addressing”) and does not fully reflect the central process of reading.

Masked priming. An elaborated method of PRIMING in which the target stimulus is immediately preceded by a prime that is presented for a very short time (normally between 30 and 60 ms, sometimes even less). With such a brief period of prime presentation, subjects are generally unaware of the nature of the prime and are surprised to learn that such a prime was presented to them at all. Before the presentation of the prime, a forward mask made of non-letter characters (e.g., #####) is presented to avoid influence by a previous visual percept. Then the prime is presented for about 50 ms, followed immediately by the target. In its appearing immediately after the prime, the target itself serves as a forward mask to the prime. In a sense then, the prime is masked before and after its presentation. The effect of the prime on reading the target is believed to result from the overlapping information contained in the prime and in the target. It is assumed that a priming effect, if found, results from earlier arousal in memory of the overlapping element in the prime and the target. For example, if the prime is a Hebrew root and the target is a word in which this root is inserted, it is often found that the presentation of the prime expedites the recognition of the target.

Morpheme. A morpheme is traditionally defined as the minimal meaningful element of a complex (polymorphic) word. Words consisting of one element (monomorphic) may themselves be considered morphemes when they are parts of polymorphic words. For example, the monomorphic word *agree* appears as a morpheme in the polymorphic word *disagree*. The meaningfulness of morphemes varies: sometimes it is defined semantically (e.g., *dis-* implies negative); at other times a morpheme indicates grammatical category, e.g., the morpheme *-ment* in the word *agreement* indicates that the word is a noun. In some cases the morpheme has no meaning at all, e.g., the morpheme *cieve* in the words *deceive*, *receive*, *conceive*, and *perceive*. A distinction is made between morphemes that can appear as independent words, e.g., *agree* in *disagreement*, and morphemes that cannot appear as independent words, e.g., *dis-* and *-ment*. The former are referred to as ‘free’ morphemes, and the latter as ‘bound’ morphemes. In linear morphology, where mor-

phemes are chained one after the other, the free morpheme (e.g., *agree* in *disagree-ment*) is sometimes defined as a root, the morpheme(s) that precede the root are referred to as prefixes, and the morpheme(s) that succeed the root are referred to as suffixes.

Semitic languages such as Hebrew and Arabic combine linear and nonlinear morphology. The nonlinear morphology is exhibited in the structure of the words' base. In every verb and most nouns the base consists of a root and a pattern that are intertwined discontinuously to form the base. The linear morphology is exhibited in the affixes used in inflections and derivations. As in non-Semitic languages, these affixes precede and succeed the word base.

Naming (Articulation). An experimental task designed to assess the complexity or difficulty of reading a word based on the assumption that reading complexity is correlated with the time of reading and the number of errors made. The reader is presented with a list of words (occasionally also NONWORDS), known as stimuli, one at a time. The reader has to articulate the stimuli as fast as possible, but with no errors. The time elapsed from the onset of the stimulus to its articulation, and the correctness of the response, are recorded and used as measures of reading complexity.

This word recognition task requires both orthographic and phonological processing. But the response does not require word comprehension, and it may not reflect normal silent reading. Some researchers believe that the naming task relies on a grapheme-to-phoneme translation, rather than on addressing the whole word in the mental lexicon.

Nonwords. Strings of letters that do not form a known word. For different experimental purposes, nonwords may be fabricated in a way that makes them similar to known words. For example, they may sound like a real word (e.g., *taybl*), contain many of the letters of a real word (e.g., *tiffernt*) or include existing sublexical elements such as syllable, stem, affix, root or pattern. Nonwords made of exclusively existing sublexical elements that form a possible word are sometimes termed "potential words."

Phoneme. The minimal unit of spoken words in a specific language. Phonemes do not represent a single specific sound, but a category of closely related sounds. The category as a whole is defined by contrast to other categories according to several phonetic parameters. For example, the only difference between the phonemes /v/ and /f/ is that the first, but not the second, is articulated with constricted vocal folds (cords). Every language has a specific set of phonemes. Some distinctions are made in some languages but not in others. For example, in Arabic there is no phonemic distinction between /b/ and /p/.

Priming. A method of presenting stimuli in tasks of word recognition such as lexical decision, naming, and categorical decision. In this method, prior (and sometimes subsequent) to the presentation of the target word, whose length of recognition is being assessed, another stimulus, known as a prime, is presented. The so called “related prime” may be a word, a nonword, or any string of letters related in some systematic manner to the target word. The relationship may involve every word characteristic: orthographic, phonological, morphological, and semantic. Normally, when the prime and the target have something in common, that is, the prime is “related” to the target, its presentation will expedite (or inhibit) the reading of the target, compared with reading a word that is “unrelated” to the target.

A *priming effect* is the difference in the length of time taken to recognize a target word in the “related” condition and the length of time taken in the “unrelated” condition. For example, in semantic priming, with the word *nurse* as a prime, the target word *doctor* (“related”) is expected to be recognized significantly faster than when the prime is semantically unrelated to the target (say, *television*).

The interval between the presentation of the prime and the presentation of the target may be systematically varied (a) by lengthening it and (b) by controlling the number of items (stimuli) intervening between the prime and the target. By manipulating these intervals, researchers can learn about the strength of the priming effect and/or the processing stage at which a prime is influential.

Productive (Productivity). A linguistic operation is productive to the extent that when repeatedly used it produces instances of the same type. For example, in plural inflection of Hebrew nouns, a fully productive operation will always affix a masculine singular noun with the suffix *-im* and a feminine singular noun with the suffix *-ot*. Productivity and predictability are correlated; for example, in a fully productive number system if it is known whether a noun is masculine or feminine the suffix of the plural form can be predicted. In less than perfect productive number system, the predictability of affixes reflects the proportion between regular and irregular words.

Regular and Irregular inflections. When a correct inflection can be produced by a Default—a linguistic rule—as opposed to memory search in the mental lexicon, we consider the inflected word as regular (e.g., *walked*). When a correct inflection cannot be produced by applying a default and must be retrieved from memory (e.g., *fell* or *thought*) we consider these words irregular.

Root and Pattern. Semitic roots and patterns are Bound Morphemes; they do not appear as independent words. The root normally consists of three consonants although four and two consonantal roots exist. Patterns consist

of the vowels by which the root consonants are articulated together with optional vowels and consonants that may or may not be considered Affixes. For example, the word *hit-kabal-ti* 'I was accepted' contains a consonantal root, K-B-L, and a pattern, hit-CaCaC-ti, where capital Cs mark open slots for the root radicals (K, B, and L in this word). In the centerpiece of this pattern one can see the vocalic pattern (-a-a-) by which the consonantal root is articulated, flanked by a prefix and a suffix. Roots and patterns are considered abstract variables in the sense that the same root may feature in different patterns to produce different words e.g., *kibal-ti*, (pattern CiCaC-ti) 'I accepted', and the same pattern may accommodate different roots e.g., *miKDaŠ* 'temple', *miŠMaR* 'watch'. The roots and the patterns have no definite meanings, although in most cases the words that share the same root share some common meaning. For example, the root G-D-L appears in the words: *gadol* 'big', *migdal* 'tower', *gdila* 'growing up', *hagdala* 'enlargement', and *gadal* 'grew up'. In every one of these words there is the semantic notion of something big or growing. The patterns of verbal forms provide syntactic information such as person, number, gender, and tense in a systematic way.

Stem. The stem, as defined in this book, is the form of the BASE when embedded in complex words and consequently has often been changed. For example, the base (and word) *derex* 'road', embedded in the following words takes different forms (printed here in bold letters): *drax-im* 'roads', *dark-i* 'my road', *ma-drax* 'monitor, manual'. Most changes of the base are restricted to the vowel pattern. Stems may be defined as allomorphs (variants) of the base.

Top-Down processing. The direction of information processing aimed at identifying an object. Top-Down processing in reading and listening begins by an educated guess of the identity of the to-be-perceived object, based perhaps on contextual hints, and continues by verifying the guess in identifying the details—the elementary units (in reading, phonemes, syllables, morphemes, letters) of which the object is made (say a spoken or a written word).

Word Decomposition. A hypothetical process of recognition and comprehension of complex words, based on the assumption that in recognizing the whole word, the reader or the listener begins by identifying sublexical elements such as bases, affixes, roots, and patterns, and then proceeds to the identification of the whole word.

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